PERSPECTIVES ON PRIONS:

MAPPING THE SOCIAL LANDSCAPE AROUND

CHRONIC WASTING DISEASE ON THE CANADIAN PRAIRIES

A Thesis Submitted to the College of
Graduate Studies and Research
In Partial Fulfillment of the Requirements
For the Degree of Master of Environment and Sustainability
In the School of Environment and Sustainability
University of Saskatchewan
Saskatoon

By

KARI AMICK

PERMISSION TO USE

In presenting this thesis in partial fulfilment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Requests for permission to copy or to make other use of material in this thesis in whole or part should be addressed to:

Director

School of Environment and Sustainability

University of Saskatchewan

Saskatoon, Saskatchewan S7N 5C8

ABSTRACT

Social perspectives on natural resources management have become an increasingly valuable part of natural resources management decision making, especially at the policy or governance level. However, due to the range of social contexts that can exist around management questions, not every technique for incorporating stakeholders into management is suited for every management problem. My research examines the social landscape around chronic wasting disease (CWD) management on the Canadian prairies in order to identify a way forward for stakeholder involvement in CWD management. CWD is a prion disease that results in neurodegeneration and death in cervids. CWD has the potential for broad social impact because it infects elk and deer, species which are both hunted and ranched. Furthermore, management and monitoring efforts in free-ranging cervids frequently incorporate hunting activity. Q methodology was used to survey stakeholders in Saskatchewan and Manitoba and synthesize perspectives about stakeholder understanding of CWD as a problem and preferences for potential solutions. The perspectives that emerged emphasized the importance of increasing knowledge about CWD and a generalized trust in government management, coupled with a desire for stakeholder consultation under the auspices of government leadership. I found that CWD management may not be ready for stakeholder spearheaded management activity due to ambivalence and uncertainty among stakeholders, but stakeholder involvement in CWD management can still offer valuable insight for managers. This is especially notable in light of the recent loss of Saskatchewan's CWD monitoring program.

ACKNOWLEDGEMENTS

It takes a village to raise a thesis, and this is doubly true of a thesis that is asking villages--or communities--to participate, as this one did. This project would not have been possible without participants, and I would like to thank them first and foremost. Thanks are also due to Prince Albert Model Forest, the Sturgeon River Plains Bison Stewards, Riding Mountain Biosphere Reserve, and the Coalition of First Nations With an Interest in Riding Mountain National Park for support in ways small and large: assistance with participant recruitment, allowing me to sit in on meetings, countless cups of coffee.

And then, for helping me to pull this from the ore: thank you to my advisor, Dr. Douglas Clark, for his support, advice, and guidance. Thank you to my committee members, Drs. Ryan Brook, Ken Belcher, and Pat Gober, and my external examiner, Patricia Farnese, for contributing their perspectives, feedback, and additional guidance. Ryan Brook deserves special acknowledgement for his support as the primary investigator for a larger project about chronic wasting disease which I have been honored to be a part of.

Financial support for this research was provided by PrioNet Canada and the Social Sciences & Humanities Research Council (in the form of a strategic research grant to Dr. Douglas Clark); I have also received support from the School of Environment and Sustainability, the University of Tromsø, and the College of Graduate Studies and Research which has allowed me to travel, learn, and eat. Additional thanks are due to the faculty, staff, and other students at the School of Environment and Sustainability for supporting both my learning and my research.

Finally: I would be remiss not to acknowledge the support I've received from friends and family throughout this process. Thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACM - Adaptive co-management

BSE - Bovine spongiform encephalopathy

CAD - Canadian dollars

CCWHC - Canadian Cooperative Wildlife Health Centre

CFIA - Canadian Food Inspection Agency

CPR - Common pool resources

CWD - Chronic wasting disease

DEZ - Disease eradication zone

DNR - Department of Natural Resources

NGO - Non-governmental organization

PAMF - Prince Albert Model Forest

PANP - Prince Albert National Park

RMBR - Riding Mountain Biosphere Reserve

RMNP - Riding Mountain National Park

Tb - Tuberculosis

TSE - Transmissible spongiform encephalopathy

USD - U. S. dollars

CHAPTER 1: INTRODUCTION

1.1 Contextualizing Chronic Wasting Disease

Chronic wasting disease (CWD) is a prion disease that causes nuerodegeneration and death in animals of the cervid family. CWD has been a presence in North American wildlife management for nearly fifty years, since it was first recognized in captive mule deer at a research facility in Colorado. CWD has been identified in captive and free-ranging white-tailed (*Odocoileus virginianus*) and mule deer (*O. hemionus*), elk (*Cervus canadensis*), and moose (*Alces alces*) (Williams & Young 1980). It is the only transmissible spongiform encephalopathy (TSE) found in free-ranging wildlife, distinguishing it from the TSEs found in domestic animals such as scrapie in sheep, and bovine spongiform encephalopathy (BSE, commonly known as mad cow disease) in cattle (Williams *et al.* 2002). TSEs in farmed species have had dramatic economic and public health impacts, and some of the concern about these diseases have transferred to CWD (Williams *et al.* 2002). CWD impacts areas as varied as cervid ranching, licensed and subsistence hunting, and ecosystem management, making the social aspects of its management difficult to untangle.

Wildlife management in North America has developed iteratively, evolving with scientific knowledge to implement a range of management activity. In Aldo Leopold's seminal treatise "Game Management" he called for further integration of scientific understanding of the interactions between species and habitat with management planning to increase effectiveness. Leopold concludes his argument by writing, "Both scientists and sportsman now see that effective conservation requires, in addition to public sentiment and laws, a deliberate and purposeful manipulation of the environment" (1939). Since Leopold wrote that, scientific

management has developed a defined set of methods for determining best practices and assessing management effectiveness. Commensurate methods for surveying the social context within which environmental management is couched are less refined. It seems that the pendulum of wildlife management has swung away from "public sentiment and laws" and into a more firmly scientific domain, although there are some management problems where public sentiment is inescapable. In many ecosystems, human communities are a broader facet of wildlife management's ecological context, and the relationships between ecological and human communities can necessitate their own management techniques.

Adaptive governance is one method for furthering the engagement of human communities in wildlife management at local and regional scales. Adaptive governance is one among a suite of methods that incorporate stake- and rights-holders into management at various levels; it also relies on iterations to ensure that management learns and changes with the ecosystem. This research uses Q methodology to assess adaptive governance as a potential method for incorporating stakeholders into CWD management decision making. CWD's position at the juncture of social and ecological systems, as a disease of popular game species that occurs in and transmits between free-ranging and farmed populations, makes the social aspects of its management of particular interest (Figure 1.1).

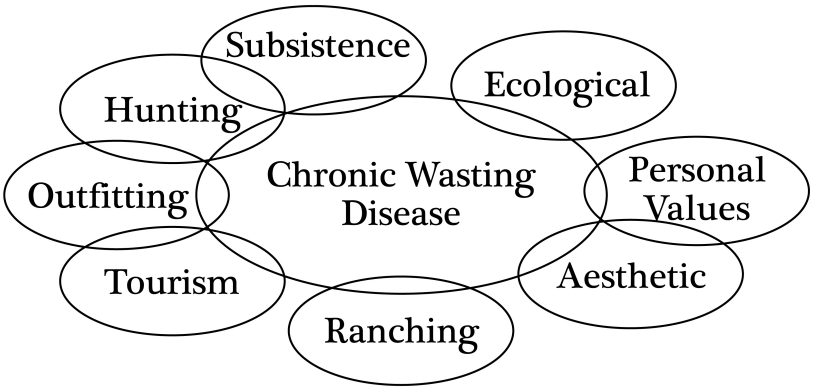

Figure 1.1 Areas where stakeholders may derive value from cervid populations, developing CWD's social impact.

1.2 Research Objectives

This research serves the parallel purposes of gaining insight into stakeholder concerns about CWD and preferences for CWD management in Saskatchewan and Manitoba and assessing the role of adaptive governance as a method for developing wildlife management plans. In order to contextualize CWD, I used interviews and Q-methodology workshops to clarify the perspectives present about CWD, with the intent of answering two central questions:

1. How do stakeholders frame CWD as a risk?

2. What are stakeholder preferences for CWD management?

This project also uses the specific instance of CWD as a case study through which to consider a broader question:

3. In what contexts is adaptive governance a useful management tool?

To address this question, the process of participating in Q-methodology workshops was considered a proxy for the workshops and discussion amongst stakeholders that are used to carry out adaptive governance (Figure 1.2).

Figure 1.2. Research framework illustrating how this research fits within adaptive governance. Adaptive governance processes incorporated into this research is shown in dark grey; processes this research does not incorporate are shown in light grey.

1.3 Research Context

CWD has been found in eighteen U.S. states and in the Canadian provinces of Alberta and Saskatchewan (Vaske 2010); however, the purpose of this study is to observe the Canadian social context of the disease. There has been some research into the social impact of CWD in Canada, with a primary emphasis on economic impacts (Petigara *et al.* 2011; Blecher & Lokken 2008), and there was stakeholder involvement in review of the Canadian National CWD Management Strategy (2011). By contrast to previous studies, this research aims to understand the perspectives of Canadian stake- and rights-holders about both CWD risk and management[1].

Two study locations were selected (Figure 1.3). In order to gain insight into how stakeholder perspectives on CWD shift as the disease becomes more prevalent, a location in Manitoba--a province where CWD has not yet been detected--was coupled with a study site in Saskatchewan, the province where CWD first appeared in Canada and has the greatest prevalence.

1.3.1 Riding Mountain National Park, Manitoba

The Riding Mountain National Park (RMNP) region which comprised the Manitoba study site consists of the primarily agricultural communities centered around RMNP, which protects fescue prairie, boreal forest, and aspen parkland (Parks

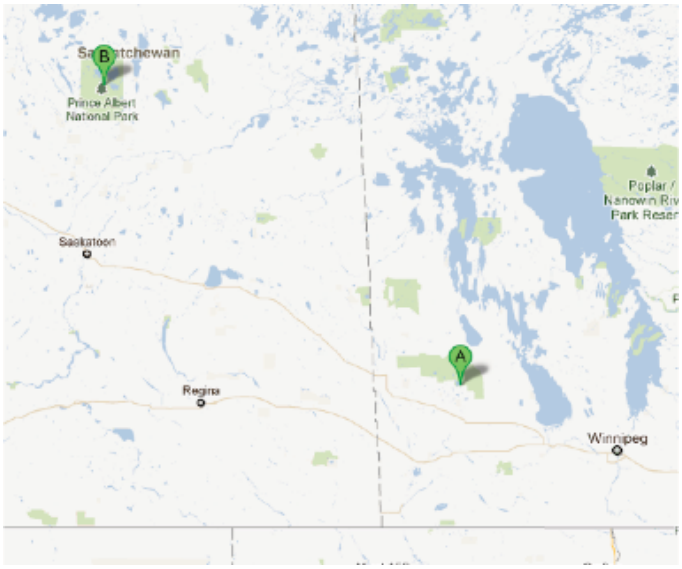

Figure 1.3. Map of Riding Mountain National Park (A) in Manitoba and Prince Albert National Park in Saskatchewan (B) (Google Maps).

[1] Although First Nations and Metís people are rights-holders due to their treaty rights (Smith 2000), for the purpose of this thesis 'stakeholders' will be used to refer to the full spectrum of involved parties, ranging from governmental representatives and First Nations to non-indigenous hunters and community members.

Canada 2007). This region was selected both for its proximity to the Saskatchewan border--the western extent of the park's boundary is within 30 kilometers of the border--and for previous instances of stakeholder involvement with wildlife management, as well as prior stakeholder concern about wildlife disease. In the RMNP region, stakeholder collaboration exists in the form of the Riding Mountain Biosphere Reserve (RMBR), which fosters collaboration between the park, 15 rural municipalities, and local First Nations, and the Coalition of First Nations With Interests in RMNP, a partnership between the park and 7 area First Nations. Furthermore, bovine tuberculosis (Tb) has been an issue in elk in this region (Brook 2009). Bovine Tb can transmit between free-ranging elk and domestic cattle, and resulted in significant stakeholder interest in elk and wildlife disease management, especially in an area, like that within the RMBR, that has significant agricultural use. The national park, which has prohibited hunting since its establishment in 1930, also serves as a reservoir for elk populations, making it a focal point for conflicts between elk and human communities (Brook 2009).

CWD has not been detected in Manitoba; as a result, the province of Manitoba monitors the border with Saskatchewan. There are billboards along the Saskatchewan-Manitoba border warning sportsmen about threat of CWD in imported game, and when elk escaped from a farm in Saskatchewan and crossed the border in 2012, Conservation Manitoba used aerial surveillance to attempt to locate and cull the animals (Conservation Manitoba 2012).

1.3.2 Prince Albert National Park, Saskatchewan

Prince Albert National Park (PANP) exists in the transitional zone between Saskatchewan's northern boreal forests and the aspen parkland region to the south. As a result, agricultural activity in this region is commingled with hunting and tourism. Like RMNP, PANP

has hosted to groups that foster stakeholder collaboration, including Prince Albert Model Forest (PAMF) and the Sturgeon River Plains Bison Stewards (SRPBS) (Kelly 2007). The potential of anthrax, which was found in the free-ranging bison herd in 2008, to transmit to domestic livestock has been a significant local concern (Shury *et al.* 2009).

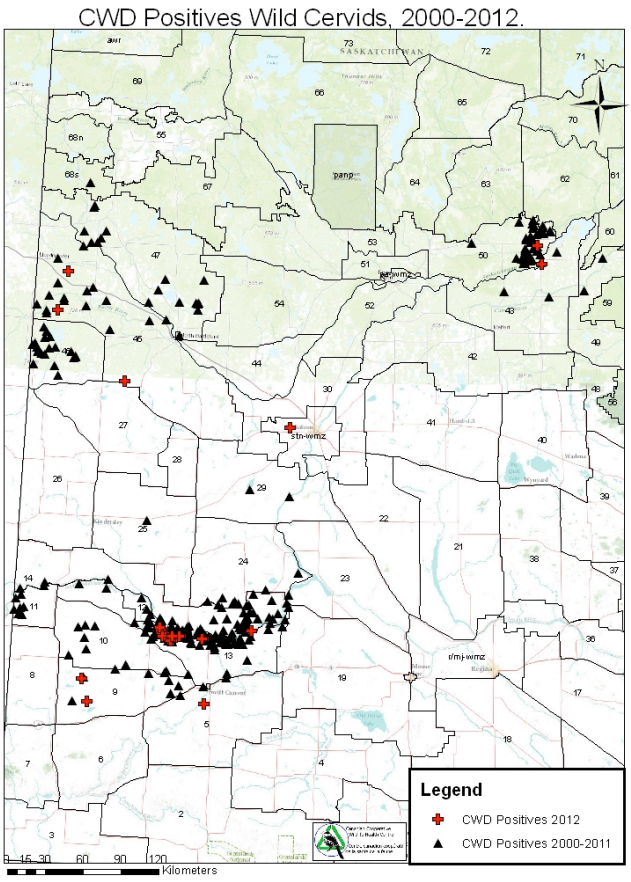

Figure 1.4. Locations where CWD has been found in wild cervids in Saskatchewan. Prince Albert National Park (PANP), the SK study location, is in the north center (CCWHC 2012).

CWD is present in Saskatchewan, however, the PANP region is not a center of its impact, as CWD has not been observed within the park (Figure 1.4). The selection of PANP despite the low prevalence of CWD was due to the existence of established stakeholder participation in natural resources management and the potential to partner with stakeholder organizations in the region, which was important to this study. Furthermore, the presence of CWD within the province means that many stakeholders view CWD as present, even if it is not in their immediate area.

1.4 Thesis Overview

This thesis surveys stakeholder perspectives on the risk and management of CWD in Canada, with a special emphasis on the potential for adaptive governance in Canadian CWD management. This research is formatted as a manuscript-style thesis. As such, this chapter,

Chapter 1, provides a brief introduction to the research background and objectives; Chapter 2 serves as a more in-depth review of the background literature. Chapter 3 presents the results of this research as an independent manuscript, intended to be submitted for publication. Chapter 4 summarizes the results of this research and expands upon their relevance and management applicability, as well as offering some of my own reflections.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In order to understand social perspectives on Chronic Wasting Disease (CWD), it is necessary to place it in context. It should come as no surprise that this disease does not exist in a vacuum, as very few things do. CWD is couched within contexts that vary in kind and scale. In order to begin exploring CWD's social context, this literature review begins by introducing CWD and its history, then discusses CWD management within the context of wildlife disease management in North America. This is followed by an exploration of the social aspects of CWD management. Finally, we will introduce adaptive governance as a policy framework for incorporating social perspectives into natural resources management.

2.2 Chronic Wasting Disease

CWD is an infectious prion disease that causes neurodegeneration and death in elk (*Cervus canadensis*), white-tailed deer (*Odocoileus virginianus*), and mule deer (*O. hemionus*) (Williams 2005). It has also been found in moose (*Alces alces*) (Williams 2005; Sigurdson 2008). CWD is a transmissible spongiform encephalopathy (TSE) similar to scrapie in sheep, and bovine spongiform encephalopathy (BSE, commonly known as mad cow disease) in cattle (Williams *et al.* 2002). CWD can be transmitted interspecifically and through saliva, urine, fecal matter, and infected carcasses; prions can also persist in the environment (Miller *et al.* 2004; Williams 2005; Smith *et al.* 2011). CWD occurs in both free-living (it is the only TSE to be found in free-ranging species) and captive cervids and, due to the various avenues available for transmission, it can also be transmitted between free-living and captive animals if precautions are not taken (Bollinger *et al.* 2004). This is noteworthy because the transport of captive cervids

likely contributed to the spread of CWD, resulting in early outbreaks of CWD in farmed populations which were more geographically extensive than those in free ranging populations (Williams 2005).

CWD was first observed in research facilities in Colorado, U.S.A., in the 1960s. It has since spread to wild and captive cervid populations across western North America (Figure 2.1) (Williams & Young 1980). In the United States, CWD is considered endemic in free-ranging deer and elk in northeastern Colorado, southeastern Wyoming, and the southwest portion of the Nebraska panhandle (Williams & Miller 2002). CWD is thought to have emerged in Canada

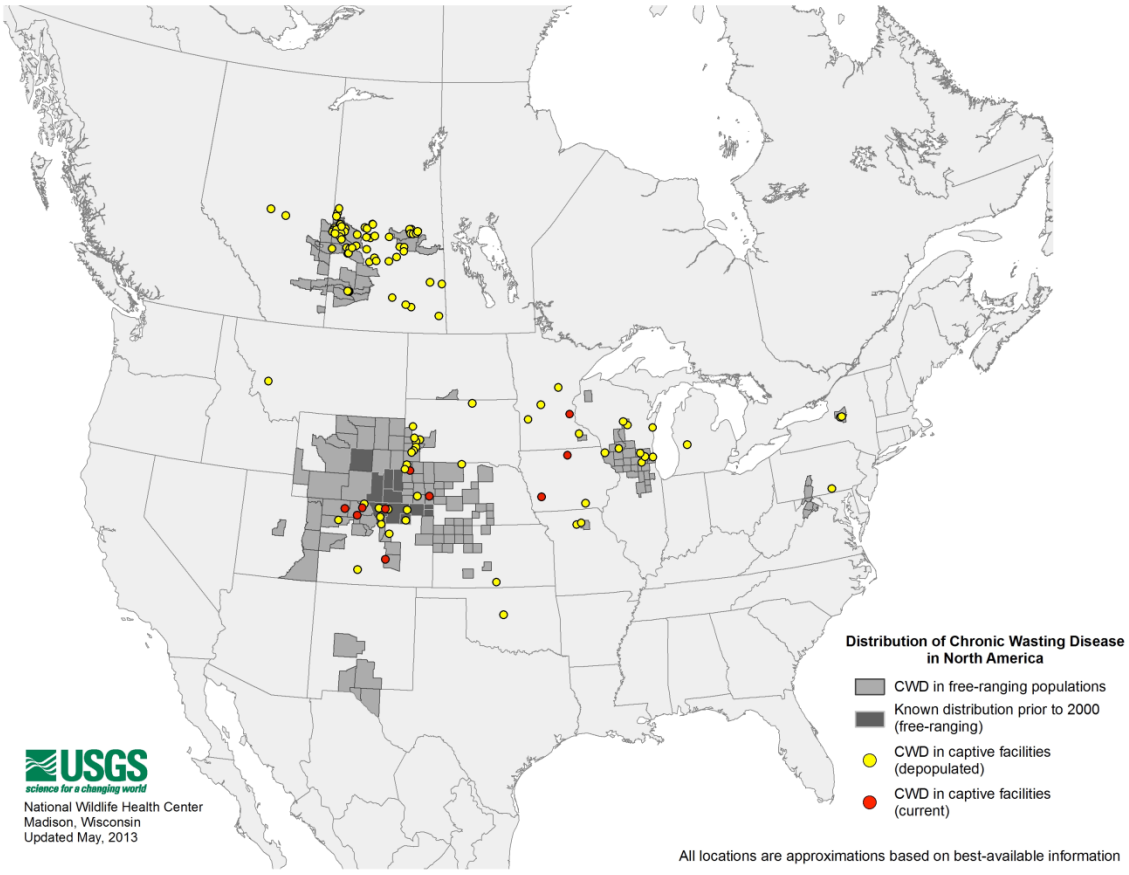

Figure 2.1. Map of CWD distribution in North America (National Wildlife Health Center 2013).

following the import of farmed elk from South Dakota to Saskatchewan. It was first found in farmed elk in Saskatchewan in 1996, and was first found in farmed white-tailed deer in Alberta in 2002 (Kahn *et al.* 2004). Infected domestic elk were also exported from Saskatchewan to South Korea in 1994 and 1997 (Kahn *et al.* 2004).

Due to its negative effect on deer and elk populations and the pressure to cull infected populations, CWD poses a significant threat to cervid populations. There is no vaccination or cure, and as a result CWD has been addressed with a range of management techniques, ranging from aggressive population reduction to simple monitoring (Williams *et al.* 2002).

2.3 CWD & Wildlife Disease Management

2.3.1 Wildlife Disease Management in North America

Extensive wildlife disease management is both difficult and uncommon because management effort must be thought to be both necessary and reasonably effective. Wobeser writes, "Management of wildlife disease is usually undertaken for some reason that will benefit humans" (2002) and describes three such instances: zoonotic diseases, diseases between wildlife and domestic animals, and diseases that occur in species that are of special value to humans (e.g. endangered species) (Gillin *et al.* 2002). Wobeser also notes four basic management strategies: preventing disease introduction, controlling an existing disease, disease eradication, and *laissez-faire* or do-nothing management (2002).

One of the fundamental difficulties of wildlife management is that this is medicine practiced on a grand scale, and individual treatment is typically only viable when dealing with very small populations (Woodroffe 1999). Instead, many techniques attempt to manage the disease at the population level. Assuming a disease's transmission is density dependent, one

technique for eradication is to harvest the species, reducing the population to the point where transmission drops off entirely (Fenichel & Horan 2007). Managing population structure--for example, by creating smaller sub-populations with lower levels of interaction--may also be a technique for managing wildlife disease on an ecosystem scale (Woodroffe 1999). However, effective management, and even effective disease monitoring to assess the need for or progress of management, can be quite difficult. It is often necessary for managers to ascertain whether undertaking disease management is a practical use of their limited resources (Rhyan & Spraker 2010; Woodroffe 1999). As a result, wildlife disease management is a uniquely complex facet of modern wildlife management.

2.3.2 CWD Risk

CWD has not yet been found to transmit to humans; it does, however, impact a suite of species that are both hunted and ranched, providing an impetus for wildlife disease management. It is also worth considering the ways in which CWD's spread has been aided by human activity, specifically cervid farming. CWD was initially identified in research facilities in the 1960s--that is to say, relatively recently--and was spread with the assistance of human activity, which may contribute to a feeling of human responsibility for managing the disease today.

The risk CWD poses to its host organisms, ecosystem, and humans has been uncertain (Belay *et al.* 2004), although its potential impact to human stakeholders is broad. Research from Wisconsin indicates that CWD caused economic losses due to the importance of white-tailed deer as a game species, with the loss of expenditures from out-of-state hunters valued at between $5 and $10 million USD (Vaske 2010). This is coupled with a loss of hunting license sales and

recreational benefit to the hunting community (Bishop 2002). In Saskatchewan, hunting has an economic impact of $200 million CAD annually (Douglas 2011). Hunting is not the only area where CWD can have an economic impact. The current policy in Canada is to depopulate infected elk and deer farms; since 2003, over 40 farms in Saskatchewan and 3 in Alberta were depopulated (Vaske 2010; Belcher & Lokken 2008). Farmers are compensated for lost stock, although many feel this is inadequate. There has been an overall decline in cervid farming: in Saskatchewan, the farmed cervid population declined from 54,000 to 22,000 between 2005 and 2010, and licensed game farms commensurately declined from 616 in 2002 to 421 in 2011(Canadian Food Inspection Agency 2013; Douglas 2011). With the collective contribution of Saskatchewan's game industry to the economy at $15 million CAD annually, this could be cause for concern (Douglas 2011).

2.3.3 CWD Management Options

The literature about CWD shows regional variation in management techniques for CWD in free-ranging populations, much of which can be correlated with how prevalent CWD is in the region's cervid population. CWD was first identified in the western United States and is now considered endemic to the area around Colorado, as well as in Wyoming and Nebraska (Williams *et al.* 2002). Eradication in this region is currently highly unlikely. Since most of the management techniques for CWD focus on either eradicating the disease or preventing its spread, management in the endemic area falls into the *laissez-fare* category of wildlife disease management and places an emphasis on monitoring CWD's spread and extent.

There are two methods for monitoring CWD; the first, called targeted surveillance, involves sampling animals exhibiting disease symptoms, while the second, more common

method, involves sampling hunter harvested animals (Conner *et al.* 2008; Williams *et al.* 2002; Beringer *et al.* 2003). Ideally, this involves collecting tissue samples from deer heads at on-site check stations, but this requires effort both on the part of wildlife monitoring agencies and hunters, and sampling the hunter harvest cannot be considered a random sample, as hunters do not harvest animals randomly (Beringer *et al.* 2003; Diefenbach *et al.* 2004).

In areas where CWD has emerged but is not yet endemic, eradication has been attempted. Two notable examples are in the U.S. states of Wisconsin and Illinois. Wisconsin's disease eradication efforts have been especially well documented in the literature. The state Department of Natural Resources (DNR) implemented a suite of measures centered around increased regulations for cervid import and transport coupled with more liberal hunting seasons intended to eliminate 90% of the deer in a designated Disease Eradication Zone through an increase in hunting (Holsman *et al.* 2010; Lischka *et al.* 2010; Bartelt *et al.* 2003).

2.3.4 Stakeholder Perspectives on CWD Management

Much of the literature on stakeholder perspectives and CWD comes from Wisconsin, where aggressive management measures produced a strong response from stakeholders. The most contentious part of Wisconsin's plan was the effort to reduce the deer population by 90% in a Disease Eradication Zone (DEZ) in the southeast corner of the state (Holsman *et al.* 2010). To accomplish this, the firearm hunting season was extended, hunting quotas were eliminated entirely, and financial incentives were used to encourage larger takes; hunters also had to shoot an anterless deer to earn a permit for an antlered animal (Holsman *et al.* 2010). This plan was created and carried out in a top-down fashion, without stakeholder consultation, because CWD was considered an urgent problem requiring urgent action (Heberlein 2004; Holsman *et al.*

2010). However, CWD was not eradicated in the DEZ, partially because hunters did not participate to the degree managers anticipated.

Surveys of hunters following this management effort in Wisconsin identified several reasons for lack of hunter support and participation. It is important to note, first, that research also found that hunters felt that something should be done about CWD; they did not feel that the disease should be ignored by the DNR (Holsman *et al.* 2010). Additionally, hunters were found to be more concerned about CWD than non-hunting landowners (Stafford *et al.* 2007). However, the management Wisconsin implemented was unpopular due to its conflict with tradition--both the tradition of archery hunting, which found its season overlapping with the firearm season under the new management plan, and the tradition of hunting bucks, which was stymied by the requirement of shooting an anterless animal before shooting an antlered one (Holsman *et al.* 2010). Surveys also found that hunters simply weren't interested in harvesting more deer, and the incentives provided weren't sufficient to alter old habits (Holsman *et al.* 2010). This was further exacerbated by the fact that, despite their desire to see the DNR address it, hunters did not perceive CWD to be a significant risk. Holsman *et al.* note that hunters expressed more concern when the disease first appeared in Wisconsin, but through their experience with CWD found it to be a more minor problem than they first believed, and scaled back their risk perception commensurately (2010). Research in Wisconsin and three other states also found that higher perceived risk--especially the potential for human death--would have the greatest impact on hunter behavior, with high levels of perceived risk causing them to cease hunting entirely (Lyon & Vaske 2010). However, the final nail in the Wisconsin eradication effort's coffin was that hunters did not believe that the DNR's plan would be effective at reducing CWD prevalence;

thus, they did not feel their participation would accomplish what the DNR said it would (Holsman *et al.* 2010; Cooney & Holsman 2010). Since these early eradication efforts, Wisconsin has adopted a new approach, incorporating a Stakeholder Advisory Group and accepting that CWD eradication in Wisconsin is unlikely at this juncture (Holsman *et al.* 2010).

2.3.5 Canadian CWD Management

Canada's National CWD Control Strategy, when it was first drafted by the Federal-Provincial/Territorial Resource Ministers Council in 2005, had the long-term goal of eradicating CWD in Canada. To do this, the council laid out six goals: preventing the further emergence of CWD, managing CWD, educating and training wildlife disease specialists, and communication, coordination, and collaboration for the achievement of these goals (Bates *et al.* 2005). The goals are based on 5 principles: collaboration, science, integration, strategic investment, and adaptive management. This National CWD Control Strategy was never implemented, however, it provides some insight into the Canadian attitude towards CWD management.

In 2011, updates to the National CWD Control Strategy were developed through practitioner workshops conducted by the Canadian Cooperative Wildlife Health Centre (CCWHC). This proposal provides a clearer vision for CWD management in Canada, and replaces the 4th goal of the original strategy, "effective management of CWD," with "research in support of CWD management." This change appears to be directly tied to an additional 6th from the 2011 proposal: "achievable: the Strategy must be realistic considering existing knowledge as well as social and economic circumstances." A further change: the proposal update says that "The ultimate objective of this Strategy is the eradication of CWD from Canada, or, failing this, the tightest possible control of CWD." This is reflected by comments made by Greg Douglas, of

the Saskatchewan Ministry of Agriculture, at one of the 2011 practitioner workshops: he said that CWD policy will be shifted from eradication to a "control and zoning" approach. Both Canada's original strategy and the proposed update have goals which are largely centered around identifying effective CWD management methods, with the presumption that management methods might be decided between--and management more actively carried out--once management methods are identified, or when or if more effective methods are found. In terms of management action, deer head testing does occur in Canada, although it is largely on a voluntary basis (Zimmer *et al.* 2012). The changes in the 2011 proposed plan recognize that, six years after Canada's first national control strategy, CWD still exists in a landscape of uncertainty that makes its management difficult; the changes may also indicate that CWD is less of a concern than it once was. However, the changes in the 2011 proposal do not mean concern about CWD is absent entirely. Research in Alberta found that hunters would be willing to pay an average of $20.35 CAD per trip to keep CWD at its current levels (Zimmer *et al.* 2012).

The U.S. preference for more aggressive management for eradication in areas where CWD is newly emergent and a focus on monitoring in areas where CWD is endemic may be paralleled in Canada (Vaske 2010; Lischka *et al.* 2010). CWD has not yet emerged in Manitoba. when escaped farm elk from Saskatchewan crossed the border in 2012, Conservation Manitoba used aerial surveillance to locate and call the elk (Conservation Manitoba 2012). However, the 6th principle of the revised strategy's emphasis on "social and economic circumstances" indicates that there are limits to the actions federal and provincial governments can be expected to take; neither Illinois nor Wisconsin were successful in their eradication attempts,

demonstrating that eradication is more easily proposed than accomplished due to technical, social, and economic constraints.

2.4 Adaptive Governance & Co-Management

2.4.1 Managing Risk

In "Risk Society" Ulrich Beck writes: "determination of risks are the form in which ethics, and with it also philosophy, culture, and politics, is resurrected *inside* the centers of modernization--in business, the natural sciences, and the technical disciplines" (1992). Beck goes on to describe how addressing and understanding risk demands cooperation between fields, creating a future-oriented risk society where the possibilities awaiting in the future determine the actions taken in the present (1992). If we apply this framework to CWD, decisions made about CWD management are based on comparing the potential risks of the disease, namely, the likelihood that it will cause significant problems for cervids, ecosystems, or humans, either directly or indirectly. However, risks must be weighed against one another, and managers must determine which risks warrant the most attention, and whether a risk should be mitigated or eliminated entirely. CWD is only one among a multitude of potential risk factors; as a result, management will only occur if the benefits of risk mitigation outweigh both the cost of management and the benefits of mitigating other risks. When CWD arrives in a region, wildlife managers are confronted with an additional problem, rather than something to which they can dedicate their exclusive attention. Thus, decisions about managing CWD must account for the risks it creates. However, risk perception can very between individuals, and, as demonstrated in the example of Wisconsin's CWD management, can have a significant impact on how stakeholders react to government management.

CWD specifically has impacts which span from the economic to the ecological, and, as a result, a range of stakeholders and rights-holders are expected to have opinions about the level of risk and the viability of management. In Canada, these groups include (but are not limited to) a spectrum of government agencies, First Nations, hunters, outfitters, elk ranchers, the tourism industry, non-governmental organizations (NGOs), and members of communities where elk are present. Beck notes that cooperation between fields can be difficult when fields speak at cross-purposes to one another (1992). Thus, it is useful to consider the methods available to integrate stakeholder perspectives into management planning.

2.4.2 Defining Adaptive Governance

Adaptive governance has been proposed as a method for incorporating public sentiment into natural resources governance and resolving conflicts between multiple interest groups, bringing policy and public opinion into a process that is sometimes considered the exclusive domain of science. Adaptive governance itself exists at the crux of a tangle of terms, among them adaptive co-management and adaptive management. This project focuses on adaptive governance; however, to understand the precise nature of adaptive governance, it will be useful to delve into the surrounding terms.

The word ‘adaptive’ tells us that adaptive governance practice exists within a continuous feedback loop, allowing managers to use science to learn from the results of their actions and adjust management plans to increase the elasticity of the management process (Ruitenbeek & Cartier 2001; Holling 1978). This is a learning process during which the results of management activity are used to reassess and course-correct for future management; if this feedback has the capacity to change underlying governance values it is a double-loop process, whereas if it does

not it is considered a single-loop process (Argyris 2002). Ideally, double-loop learning will be in place. Adaptive management also incorporates feedback from both social and environmental systems (Jones 2009). However, in terms of governance patterns the emphasis of adaptive management remains on scientific management, as it follows a pattern of top-down control based on a scientific understanding of the context, with learning that could perhaps be better described as single-loop, as feedback does not typically have the capacity to adjust governance values (Brunner *et al.* 2005).

Co-management is a system of management developed to facilitate the sustainable use of common pool resources (CPR), natural resources which are held and used in common, their wealth shared between many individuals (Ostrom 1990). CPR can result in the so-called "tragedy of the commons," which occurs in uncontrolled systems where benefits from the overuse of CPR are received by individuals, while the cost of overuse is shared among many, encouraging overuse (Hardin 1968). Co-management is power sharing between the state and resource users to effectively manage CPR and preclude the tragedy of the commons (Carlsson & Berkes 2005). The 'co' prefix, from the Latin for 'with,' indicates a shared or joint responsibility for the management process, but in co-management this exists along a continuum which can range from information sharing to formalized partnerships (Pomeroy & Berkes 1997). Recently, emphasis has been placed on co-management as a process through which management can develop and change, leading to a new system: adaptive co-management (ACM) (Berkes 2009).

Like ACM, adaptive governance is a social process intended to develop more effective management for social-ecological systems by encouraging power sharing and learning to allow elastic response to change. Like adaptive management, adaptive governance relies on feedback

loops, but adaptive governance uses these loops to encourage douple-loop learning in the governance system. The distinction between management and governance can be described thus: governance is the framework within which management exists, while management is the process of bringing governance vision into practice. Monitoring provides the feedback necessary to encourage learning and make the process adaptive (Boyle *et al.* 2005; Folke *et al.* 2005). When this learning occurs only in the area of management, the process is a single-loop learning system; when the learning impacts both management and governance, it is a double-loop system (Argyris 2002). In this way, adaptive governance subsumes adaptive co-management and serves as a way to resolve the fragmentary goals that can manifest in the co-management process by incorporating elasticity into the governance framework itself (Brunner *et al.* 2005). However, there is often minimal practical distinctions between what the literature recognizes as adaptive governance and ACM, as both are forms of what Ansell and Gash call "collaborative governance" (2007). Ruitenbeek and Cartier's definition of ACM is very similar to the definition of adaptive governance: "A long-term management structure that permits stakeholders to share management responsibility within a specific system of natural resources, and to learn from their actions" (2001). For this reason, as we continue examples will be drawn from both the adaptive co-management and adaptive governance literature as appropriate.

2.4.3 Establishing Adaptive Governance

Describing ACM, Ruitenbeek and Cartier write: "Policy makers often think of ACM as a strategy that one can introduce into a system, or into part of a system. In fact, however, ACM is no strategy" (2001). The authors go on to argue that ACM can be a property that emerges from the system itself *or* a strategy that is developed and designed. Ruitenbeek and Cartier's research

suggests that “naturally and more emergent regimes seem to be the most resilient” and go on the propose three hypotheses about the emergent quality of ACM and the possibility of imposing ACM: firstly, that with increased complexity ACM will evolve and emerge naturally in systems; secondly, imposed ACM may fail due to a mismatch between system complexity and the management scheme; and, thirdly, that premature introduction of ACM may cause system failure because the introduction of ACM interrupts the evolutionary process which produces ACM (2001). Armitage, *et al.*, describe ten conditions for successful ACM. These fall into three categories. Several of these conditions are traits of the resource itself--small in scale, immobile, with clearly delineated use rights. Others describe the management options and capacity: there should, Armitage, *et al.*, say, be the ability to apply and test a variety of management measures as necessary, and the existing policy should support collaborative management. Finally, some factors relate to the social context of management: the presence of key leaders, the openness of participants to incorporating multiple sources of knowledge (2009). This reinforces the notion that adaptive governance exists as a marriage of resource, management capacity, and social context.

Adaptive governance acknowledges the potential for conflict between various values and perceptions, typically emerging out of specific contexts. However, it is common for adaptive governance to grow out of a mutual desire for collaboration or resolution of a shared goal rather than conflict (Brunner *et al.* 2005). In the same vein, the network of actors that coalesce to form an adaptive governance network can also vary contextually (Rijke *et al.* 2012). As a result of its emergent qualities and high context dependence, adaptive governance should not be treated as a

panacea, but instead its usefulness should be evaluated through the lens of the specific issue it is addressing.

2.5 Gaps in Current Research

Questions remain about adaptive governance's usefulness under certain conditions. Although stakeholder participation has emerged as part of Wisconsin's new CWD management plan, adaptive governance for CWD has not spread with the disease (Holsman *et al.* 2010). If adaptive governance for CWD has not emerged organically, is there sufficient sustained community interest in using adaptive governance to address CWD to ensure stakeholder participation? Currently, the literature about adaptive governance is focused on using it to resolve conflict, but little of it has addressed a conflict managers sometimes face when they attempt to incorporate stakeholders into their management planning: the conflict between the desire for stakeholder participation and public indifference. It would seem that understanding stakeholder opinions could head off conflicts between management activity and stakeholder interests; however, stakeholders may be content to trust their natural resource managers until conflict occurs, and thus stakeholder participation cannot be used preventatively. Management activity in Wisconsin have demonstrated that CWD is an issue for which adaptive governance may be useful, but since no adaptive governance has emerged naturally, this disease provides a unique opportunity to assess both stakeholder perspectives on CWD and the potential usefulness of adaptive governance in addressing conflicts before they emerge.

Few studies about the human dimensions of CWD account for stakeholder preferences for management prior to management activity. Stakeholder preference research has also been strictly regionally bounded, with most of the available literature focusing on the United States,

specifically Wisconsin and Illinois, and there is relatively little CWD research from Canada. Results indicate that the response to CWD and its management can vary regionally, reinforcing the importance of understanding specific regional contexts when planning for CWD management. Furthermore, the difficulties faced in Wisconsin indicate that stakeholder support can have a dramatic impact on management effectiveness. Moving forward, incorporating stakeholders into CWD management may be an important step towards increasing the effectiveness of said management.

CHAPTER 3: Stakeholder Perspectives on Chronic Wasting Disease Risk & Management

3.1 Abstract

Chronic wasting disease (CWD) is an infectious prion disease resulting in nuerodegeneration and death in cervids. As a threat to North American deer and elk, it poses an unanswered wildlife management question. CWD exists in a landscape of uncertainty characterized by questions about how it may best be managed. This study approaches the question of CWD management from a social perspective, using Q-methodology to understand stakeholder perspectives on CWD risk and management in Canada and assess the potential for stakeholder involvement in CWD management. Workshops and individual interviews about CWD problems and solutions were conducted in Saskatchewan and Manitoba with a total of 16 participants from rural municipalities, provincial, federal, and First Nations government agencies, academia, farming, hunting, and NGOs. Four perspectives on problems were identified (labeled as *Ranching*, *Hunting*, *Ecology & Information*, and *Management Responsibility*) and four for solutions (*Knowledge Sharing*, *Government Leadership*, *Risk Management*, and *Cervid Importance*). Notably, all solution perspectives agreed on the importance of education and the idea that management should fit within a national management strategy. These results indicate that while stakeholders wish to be involved in CWD management, they also trust and expect government leadership. We identify key challenges for stakeholder involvement with Canadian CWD management as a lack of sufficient leadership coupled with general ambivalence.

3.2 Introduction

3.2.1 Chronic Wasting Disease

Chronic wasting disease (CWD) is an infectious prion disease that results in nuerodegeneration and death in cervid species; it has primarily been found in white-tailed deer, mule deer, and elk, although it is also known to effect moose. It does not transmit to humans or non-cervid livestock, although it is a transmissible spongiform encephalopathy (TSE) like scrapie in sheep, bovine spongiform encephalopathy (mad cow disease), and Creutzfeld-Jakob disease in humans (Belay *et al.* 2004). Since being identified in captive herds of mule deer in Colorado, U.S.A., in the 1960s, the disease has spread to wild and captive herds in eighteen U.S. states and to the Canadian provinces of Alberta and Saskatchewan (Vaske 2010). Transmission can occur interspecifically and through contact with saliva, urine, fecal matter, and infected carcasses; furthermore, prions can persist in the environment (Williams 2005; Miller *et al.* 2004; Smith *et al.* 2011). CWD's spread has been aided by human activity; CWD first appeared in captive elk populations in Canada following the importation of animals from South Dakota, prompting the depopulation of 40 cervid farms in Saskatchewan and 3 in Alberta between 2000 and 2003 (Kahn *et al.* 2004; Belcher & Lokken 2008). Transmission risk can also be increased by the practice of baiting and feeding deer (Thompson *et al.* 2008; Brown & Cooper 2006). Furthermore, it is a disease that impacts species which have a significant role both as game and as ranched livestock; as a result, CWD has become an issue of management interest.

3.2.2 CWD Management Options

Techniques for managing CWD are varied but all have had limited effectiveness thus far. The selection of a management technique often correlates with how long CWD has been present in a region and how prevalent it is in the cervid population. In the area of the western United States where CWD is considered endemic, most effort has been directed towards monitoring the

disease's spread and prevalence (Williams & Miller 2002). This is commonly accomplished through either targeted surveillance, where animals that exhibit symptoms of CWD are collected and sampling, or through the sampling of hunter harvested animals (Conner *et al.* 2000; Williams *et al.* 2002; Beringer *et al.* 2003). Head collection programs, which sample tissue from the heads of hunter killed animals, are common both in areas where CWD is present and where it is thought it might emerge, but require effort both from wildlife monitoring agencies and hunters (Beringer *et al.* 2003; Diefenbach *et al.* 2004).

If an attempt is made to manage CWD in a free-ranging cervid population, the goal is typically either complete eradication of the disease or transmission reduction, which can take the form of reducing transmission rates in general or preventing transmission to new populations or regions. A suite of methods have been used to achieve these goals. Herd depletion has been thought to be an effective technique for reducing transmission, although eradication attempts in Wisconsin raise questions about its effectiveness (Holsman *et al.* 2010; Lischka *et al.* 2010; Bartelt *et al.* 2003). Other options include landscape level management to reduce herd interaction and transmission and cervid transport and import regulations (Woodroffe 1999; Holsman *et al.* 2010; Bartelt *et al.* 2003).

3.2.3 Stakeholder Perspectives on CWD Management

Much of the social research on CWD management has focused on Wisconsin, where eradication was attempted. In Wisconsin eradication efforts relied heavily on the participation of recreational hunters to deplete deer herds and reduce transmission rates. This management plan suffered from a lack of participation, partially due to a decrease in concern about CWD and stakeholder fear that depleting the deer herd would reduce hunting opportunities without

effectively lowering transmission rates (Holsman *et al.* 2010; Cooney & Holsman 2010). Wisconsin's management has since become less aggressive and employed stakeholders in the management planning process, but eradication has not been achieved (Holsman *et al.* 2010; Blanchong *et al.* 2006). Research in Illinois, where eradication was also attempted, found that stakeholders were not especially interested in or engaged with CWD management (Lischka *et al.* 2010). In general, concern about CWD has been found to be greater among hunters than in the general population (Stafford *et al.* 2007). Studies have found that hunter support for management via deer herd reduction might be increased if CWD were perceived as a greater risk to human health (Cooney & Holsman 2010; Vaske 2010). Research also shows that if CWD were perceived as a threat to human health, hunting activity would be greatly reduced, which may be counter-productive to herd depletion but also indicates a larger level of stakeholder concern about the disease with greater threat levels (Lyon & Vaske 2010; Needham *et al.* 2004).

3.2.4 CWD Management in Canada

Early CWD management in Canada envisaged a goal of complete disease eradication in both wild and domestic animals (Bates *et al.* 2005). However, proposed updates to Canada's National CWD Control Strategy shift the goal slightly: "The ultimate objective of this Strategy is the eradication of CWD from Canada, or, failing this, the tightest possible control of CWD" (CCWHC 2011). Canada has also placed an emphasis on the identification of effective management techniques, asking questions about whether the techniques currently available are effective and efficient for CWD management. As a result, Canada's CWD management has mostly involved containing the spread of CWD by regulating cervid transport and monitoring its extent through head collection programs, although head collection programs have been sporadic

at best. Both of these methods involve the participation of stakeholders such as hunters and ranches. Head collection programs are not mandatory in most areas and rely on hunters bringing in their harvested animals (Kahn *et al.* 2004; Zimmer *et al.* 2012). Canada's National CWD Control Strategy includes collaboration as a key principle, and the proposed updates to the National CWD Control Strategy were developed in 2011 through workshops that included a variety of stakeholder groups, indicating that managers are aware of the role stakeholders can play in CWD management (Bates *et al.* 2005; CCWHC 2011). This National CWD Control Strategy has not been an enacted, and instead CWD regulation is carried out by a patchwork of federal and provincial organizations regulating animal and human health. Research on stakeholder perspectives about CWD in Canada has been minimal.

3.2.5 Research Objectives

This research aimed to gain insight into stakeholder perspectives on CWD in Canada. The uncertainty around current management options means that there is no easy management solution to CWD; as a result, stakeholder input can be useful in selecting between various methods, especially as all CWD management options incorporate stakeholders to some degree. As a result, understanding stakeholder perspectives about CWD may be useful in determining whether a particular management option will be effective in a region. Our objectives were to understand how stakeholders frame CWD as a risk and what stakeholders perceive as potential solutions to CWD.

3.3 Methods

3.3.1 Q Methodology

Q methodology was selected for this study due to its capacity of extract participant's perspectives. Q methodology is considered a study of human subjectivity--defined here as "a person's communication of his or her point of view...anchored in self-reference" (McKeown & Thomas 1988; Stephenson 1953). Researchers have used Q methodology as a component of stakeholder problem solving workshops, making it an excellent method to both extract stakeholder perspectives and incorporate those perspectives into planning (Rutherford *et al.* 2009). Q methodology asks participants to map their perspectives by sorting statements, called a concourse, along a normal distribution curve; these sorts can then be factor analyzed, allowing for perspectives to be extracted (McKeown & Thomas 1988; Webler *et al.* 2009).

We conducted research in three phases. First, a concourse of statements was developed through stakeholder interviews. This was followed by a workshop in each location where stakeholders participated in further concourse development and Q sorts. Due to low participation in workshops and in order to incorporate further stakeholder perspectives, a third phase was added where stakeholders completed individual Q sorts and interviews with a researcher.

3.3.2 Locations

We selected two study locations to allow for comparison of perspectives on CWD before and after its emergence in a region. The first study site was the region around Prince Albert National Park (PANP) in Saskatchewan; the second site was centered around Riding Mountain National Park (RMNP) in Manitoba. Both parks have large reservoirs of CWD-free cervid populations, and both regions also have active stakeholder groups involved with natural resources and wildlife disease management (Kelly 2007; Brook 2009; Brook *et al.* 2006). CWD is present in Saskatchewan and but has not yet been observed in Manitoba. As a result,

management activities differ between the provinces, and it follows that stakeholder opinion may differ as well. At the time of the study, the Saskatchewan/Manitoba border was posted with billboards warning hunters about transporting cervid game due to CWD risks.

3.3.3 Participant Recruitment

Prince Albert Model Forest (PAMF) and Riding Mountain Biosphere Reserve (RMBR) provided assistance in study planning and participant recruitment. We recruited participants from study regions using snowball sampling with guidance and collaboration from PAMF, RMBR, and individual stakeholders (Goodman 1961). This was undertaken by asking PAMF and RMBR to identify key stakeholders, then inviting these stakeholders to suggest further participants. Snowball sampling was intended to ensure that stakeholders with an interest in the issue would be recruited, and that all members of small populations (in this case, populations either involved with adaptive governance or concerned about CWD) might be located (Morgan 2008). Snowball sampling was especially important during the concourse development phase of this project in order to locate especially knowledgeable stakeholders; for the workshops, general invitations were also issued to the community in local news sources. In Manitoba, these invitations produced two new participants, in Saskatchewan, they did not produce any additional participants.

3.3.4 Concourse Development

We conducted interviews for concourse development between August and September, 2012. Interviews were audio recorded and focused on open-ended questions about how participants framed CWD as a risk and what they considered to be ideal management solutions (Appendix A). A total of five interviews were completed; in Saskatchewan, a Parks Canada

employee and a landowner were interviewed, and in Manitoba an ecotourism operator, Manitoba Conservation employee, and Parks Canada employee were interviewed. Concourse statements were also drawn from education materials released by Environment Saskatchewan and Conservation Manitoba. 22 statements were developed from these sources; five of these are classified as value statements, five as risk statements, and the remainder are management statements (Appendix B). One concourse was used in both locations to enhance comparability between study sites. To ensure that the concourse be complete, concourse development was also incorporated into the Q workshops; the concourse development that occurred during workshops resulted in some differentiation between the study sites.

3.3.5 Q Workshops

We conducted two Q workshops: one in Manitoba in October 2012, and one in Saskatchewan in November of the same year. Both workshops involved a facilitator and an assistant; the Manitoba workshop included one further assistant. During each workshop, the first portion was used to review the statement set and develop further statements to fill any gaps in the concourse.

During the second portion of the workshop participants completed two Q sorts with a single statement set: the first sort was done with respect to defining CWD as a problem, while the second evaluated CWD solutions. Due to the fact that they were using the same statements for two sorts, participants were instructed to place statements they felt strongly positively or negatively towards at the extreme ends of a normal distribution curve at the beginning of each sort so that the statements that might be less applicable would end up near the middle of the Q sort.

The Manitoba workshop had nine attendees representing Parks Canada, several rural municipalities, and private interests; the Saskatchewan workshop only had one participant, a landowner.

3.3.6 Individual Q Sorts

Individual Q sorts were conducted during the month of December, 2012, using the original 22 statement concourse and the 7 additional statements developed during the Manitoba workshop. The Manitoba statement set was used for two reasons: firstly, it overlapped with the statements developed in Saskatchewan; secondly, more participants had used it, and sorts completed using the same statement set could be compared to one another using factor analysis. These Q sorts were audio recorded and included a brief interview component intended to capture perspectives that might not appear in the concourse. Eight additional Q sorts were completed this way: one with a First Nations participant in Manitoba, and seven in Saskatchewan with two NGO employees, a Parks Canada employee, an Environment Saskatchewan employee, a hunter, and two employees of First Nations governments. One researcher also completed a Q sort in order to incorporate a researcher perspective into the results.

3.3.7 Analysis

We used our analysis to extract key factors by which participants completed their Q sorts; these factors share certain implicit understandings of CWD risk and management. Similarities and points of conflict between factors were also identified.

3.3.8 Factor Analysis

Factor analysis of Q sorts can be divided into two parts: statistical analysis, which is used to identify factors that emerge from aggregating individual Q sorts, and narrative building, which

uses qualitative methods to translate these factors into coherent perspectives or narratives. Statistical analysis for this project was completed using PQMethod (Schmolck & Atkinson 2002) to calculate correlations amongst Q sorts and factor analyze the results. Factors were rotated using varimax rotation (Mattson *et al.* 2006). For the initial factor analysis, only Q sorts using the 29 statement concourse developed at the Manitoba workshop were used. Participants from Manitoba and Saskatchewan were included for a total of 13 participants, allowing for both larger data set and comparison between provinces. Three different analyses were run: one with the problem definition sorts, one with the solution identification sorts, and a third with problem definition and solution identification sorts aggregated. We selected the number of factors to be analyzed through an iterative process intended to identify factors with cohesive narratives and maximum participant adherence while also minimizing the number of factors. This was accomplished by running the analyses repeatedly, extracting different numbers of factors each time (the number of factors extracted ranged from two to eight), and qualitatively comparing the resultant factors to identify those which presented distinct perspectives while closely adhering to participant sorts.

3.3.9 Atypical Sorts

Three participants' sorts were atypical and could not be entered into PQMethod, either due to unique statements produced and used by participants or because the forced distribution of Q method was not followed precisely. PQMethod has no way to address these variations, so these sorts were qualitatively analyzed individually and compared to the factors that were extracted using PQMethod. We will discuss these separately below.

3.4 Results

Four factors were extracted describing CWD problems and four describing CWD solutions (Table 3.1). We named the problem factors *Ranching*, *Hunting*, *Ecology & Information* and *Management Responsibility* (Table 3.2); solution factors were called *Knowledge Sharing*, *Government Leadership*, *Risk Management* and *Cervid Importance* (Table 3.3). These names describe key concepts that emerged from each factor; we also theorize about the narrative of CWD and CWD management that leads to each factor. These narratives emerge from qualitative researcher interpretation and are not prescriptive.

Table 3.1. Study participants' affiliations, locations, and their factor loadings, as their extracted from Q-Sorts about defining CWD as a problem and identifying ideal solutions. * indicates the factor on which a participant is loaded.

Affiliation		Problem Definition				Solution Identification			
		Ranching	Hunting	Ecology	Manage.	Know.	Govern.	Risk	Cervid
Hunter	SK	0.01	0.74*	0.15	0.22	0.22	0.41	0.43	0.65*
Hunter	SK	0.76*	0.09	0.16	0.31	0.68*	0.36	0.16	0.21
NGO	SK	0.45	0.67*	-0.06	0.14	0.70*	0.36	0.09	0.06
NGO First Nations	SK	-0.03	0.33	-0.61*	0.30	0.78*	0.04	0.00	-0.09
NGO First Nations	SK	-0.12	0.63*	-0.17	0.55	0.08	0.89*	-0.08	0.09
Government	SK	0.25	0.44	0.26	0.58*	0.33	0.76*	0.33	0.11
Government	SK	0.80*	0.10	-0.11	0.14	0.10	0.03	-0.04	0.95*
Rural Municipality	MB	0.11	0.30	0.76*	0.21	-0.31	0.29	0.81*	0.04
Rural Municipality	MB	0.47*	0.19	-0.30	0.25	0.65*	0.07	0.55	0.17
Rural Municipality	MB	0.82*	0.07	0.25	0.09	0.37	0.08	0.76*	0.01
Outfitter	MB	0.20	0.81*	-0.04	-0.20	0.26	0.71*	0.34	0.02
Landowner	MB	0.37	0.13	0.10	0.62*	0.62*	0.07	0.55	0.17
Researcher	-	0.34	-0.11	-0.21	0.80*	0.75*	0.17	0.00	-0.09

3.4.1 Problem Factors

3.4.1.1 Ranching

The narrative of the *Ranching* factor frames CWD as a problem created by elk ranching and the associated transmission risks, and a problem because of the threat CWD poses to elk and deer, not due to any potential for CWD to have ecosystem level impacts. Adherents to this factor emphasized statements about human activity that increases transmission risks, specifically elk ranching and the transport of cervids (statements 25, 26). There was a secondary emphasis on the importance of elk and deer, both as part of the landscape and individually (1, 2, 3). This factor also gave a strong negative loading to a statement about the role of predators in CWD management (14). The four participants who positively loaded on (that is to say, agreed with) this factor included two RM representatives, a provincial government employee, and a hunter.

3.4.1.2 Ecology & Information

This factor presupposes CWD is a problem, and instead moves past that to the problem of CWD management, which it understands to be a community problem that has emerged because of the lack of scientific knowledge about CWD and also the lack of community knowledge on CWD. One participant loaded on this factor noted, "You need to win my support, [you] can't force me based only on science." Although this statement was in specific reference to the participant's rejection of a statement about management based exclusively on science (16), it also expresses the notion that scientific knowledge needs to be shared--needs to be used to educate and win management support. This seems to align well with this factor's emphasis on information sharing and community, expressed through an emphasis on statements that place CWD within a larger ecological and social context, framing CWD as a problem of insufficient knowledge (15, 22) and emphasizing the importance of community involvement (11). Despite being a problem definition sort, several solution focused statements were given high positive

Table 3.2. Statements which stakeholders strongly agreed with or which were defining for each factor that emerged from a Q-Sort about CWD problem definition, as well as consensus statements between factors. * indicates distinguishing statements for each factor. Statements highlighted in yellow were key to how the factor narrative was interpreted, those in orange were secondarily involve in narrative interpretation, and those in red are key statements of disagreement.

	Factor 1: Ranching	
25	Elk ranching has been a significant, high-risk factor.	+3
26	Transporting live animals for relocation is a high risk.	+3
1	I like sharing my land with elk and deer	+2
2	Elk and deer are aesthetically important to me.	+2
3	Elk and deer are important to me as part of the larger landscape.	+2
21	Those who are impacted by CWD should be involved in management.	+2
9	Elk and deer populations are already too low.	+1*
8	Farmers are concerned about CWD and its impacts.	+1*
5	CWD is part of a larger problem.	0*
15	It's important that management policy understand the impact on wildlife, ecosystems, and people.	-1*
14	Predators are an important part of CWD management.	-3*

	Factor 2: Ecology & Information	
5	CWD is part of a larger problem.	+3
15	It's important that management policy understand the impact on wildlife, ecosystems, and people.	+3*
11	Everyone within the community should be involved in developing management that the government enacts.	+2
12	Government organizations have the most significant role in actively managing CWD.	+2
22	Education on CWD is important.	+2
3	Elk and deer are important to me as part of a larger landscape.	+2
20	Management decisions should take into consideration what has been tried elsewhere.	+1*
25	Elk ranching has been a significant, high-risk factor.	0*
24	Hunter sampling is an issue.	-2*
6	CWD will get here eventually.	-2*
9	Elk and deer populations are already too low.	-3*
16	Management decisions should be exclusively based on science.	-3*

	Factor 3: Hunting	
24	Hunter sampling is an issue.	+3
13	Everyone within the community has a responsibility to help address CWD.	+3*
25	Elk ranching has been a significant, high-risk factor.	+2
2	Elk and deer are aesthetically important to me.	+2
10	There's less hunting because of CWD.	+2*
11	Everyone within the community should be involved in developing management that the government enacts.	+2
19	CWD management should fit within the national CWD management strategy.	-2*
21	Those who are impacted by CWD should be involved in management.	-2*
15	It's important that management policy understand the impact on wildlife, ecosystems, and people.	-2*
23	Responsibility should be identified and allocated.	-3*
8	Farmers are concerned about CWD and its impacts	-3*

	Factor 4: Responsibility	
3	Elk and deer are important to me as part of a larger landscape.	+3*
22	Education on CWD is important.	+3
23	Responsibility should be identified and allocated.	+2*
24	Hunter sampling is an issue.	+2
25	Elk ranching has been a significant, high-risk factor.	+2
26	Transporting live animals for relocation is a high risk.	+2
18	For effective management science should be better at engaging laypeople.	+1*
15	It's important that management policy understand the impact on wildlife, ecosystems, and people.	+1*
2	Elk and deer are aesthetically important to me.	0*
5	CWD is part of a larger problem.	-2*

	Consensus Statements	
17	CWD management should transcend boundaries.	0
7	Hunters are concerned about CWD and its impacts.	0

loadings, especially those which involved community management and education. Of the four participants who loaded on this factor, two were involved with an NGO, one worked in First Nations government, and one was an outfitter.

3.4.1.3 Hunting

The *Hunting* factor is distinguished by its tendency to view problems through the lens of their relationship to hunting and hunter activity. There is an emphasis on statements about the parallel issues of hunter sampling and hunting decrease (24, 10). Like the *Ranching* factor, it emphasizes ranching as a risk (25), and like the *Ecology & Information* factor it touches on the role of the whole community in management (11). This factor also emphasizes a statement saying "Everyone within the community has a responsibility to help address CWD" (13) that was not supported by other factors; the emphasis on responsibility may also tie to concern about hunter sampling, indicating that this factor feels hunters have a responsibility to participate in sampling programs. Only two participants mapped on to this factor and one, an NGO affiliate, was negatively loaded, meaning that their sort turned the factor on its head and emphasized statements about responsibility that the other participant had negatively loaded (23, 15), making this sort more similar to the fourth and final factor, *Management Responsibility*.

3.4.1.4 Management Responsibility

For the *Management Responsibility* factor, the central problem of CWD management is the fact that no group or agency has accepted the responsibility for the introduction of CWD or its management. Yoking the question of responsibility for CWD as a problem to that of responsibility for CWD management, one of the adherents to this factor suggested that the ranching industry should play a leadership role in CWD management. This factor explicitly

emphasizes statements about responsibility for CWD management (23). Like the *Ecology & Information* factor, this factor presupposes CWD is a problem, and then attempts to understand the problem in terms of which difficulties CWD management has to overcome. Three participants mapped onto this factor, including a landowner, a government employee, and the researcher.

3.4.1.5 Consensus Statements

PQMethod identified two consensus statements in this sort; however, both were ranked near the middle of the sort, suggesting that there was only consensus in what participants felt indifferent or ambivalent towards. A few broader pieces of consensus emerged from the four factors: each supported at least one of the factors about the importance of elk and deer (1, 2, or 3). There was also overlap between the *Ecology & Information* and *Management Responsibility* factors about the importance of education. In most cases, differences between factors were of degree, rather than of kind; that is to say, factors tended to support similar statements, but each factor supported them to different degrees, suggesting varying underlying interpretations of CWD as a problem.

3.4.2 Solution Factors

3.4.2.1 Knowledge Sharing

This factor views CWD as something which should be addressed by increasing the transmission of knowledge about CWD. As one participant noted: "Whenever there's a problem, education is <u>always</u> the answer." This factor sees educating both managers and the public as a solution to CWD. Its narrative is similar to that of the *Ecology & Information* factor from the problem definition sorts, however, it is not quite so strongly ecological oriented; this suggests

Table 3.3. Statements which stakeholders strongly agreed with or which were defining for each factor that emerged from a Q-Sort about CWD solutions, as well as consensus statements between factors. * indicates distinguishing statements for each factor. Statements highlighted in yellow were key to how the factor narrative was interpreted, those in orange were secondarily involve in narrative interpretation, and those in red are key statements of disagreement.

	Factor 1: Knowledge Sharing	
20	Management decisions should take into consideration what has been tried elsewhere.	+3*
22	Education on CWD is important.	+3
21	Those who are impacted by CWD should be involved in management.	+2*
23	Responsibility should be identified and allocated.	+2
19	CWD management should fit within the national CWD management strategy.	+2
15	It's important that management policy understand the impact on wildlife, ecosystems, and people.	+2
18	For effective management science should be better at engaging laypeople.	+1*
24	Hunter sampling is an issue.	0*
4	CWD is a natural part of the environment.	-3*

	Factor 2: Government Leadership	
12	Government organizations have the most significant role in actively managing CWD.	+3
13	Everyone within the community should be involved in developing management that the government enacts.	+3*
11	Everyone within the community has a responsibility to help address CWD.	+2
15	It's important that management policy understand the impact on wildlife, ecosystems, and people.	+2
23	Responsibility should be identified and allocated.	+2
22	Education on CWD is important.	+2
14	Predators are an important part of CWD management	+1*
28	There are more elk on the landscape in smaller groups now because of rural depopulation.	-2*

	Factor 3: Risk Management	
25	Elk ranching has been a significant, high-risk factor.	+3
26	Transporting live animals for relocation is a high risk.	+3*
12	Government organizations have the most significant role in actively managing CWD.	+2
24	Hunter sampling is an issue.	+2*
22	Education on CWD is important.	+2
11	Everyone within the community has a responsibility to help address CWD.	+2
13	Everyone within the community should be involved in developing management that the government enacts.	+1*
3	Elk and deer are important to me as part of a larger landscape.	-1*
18	For effective management science should be better at engaging laypeople.	-3*

	Factor 4: Cervid Importance	
1	I like sharing my land with elk and deer.	+3*
2	Elk and deer are aesthetically important to me.	+3*
19	CWD management should fit within the national CWD management strategy.	+2
25	Elk ranching has been a significant, high-risk factor.	+2
8	Farmers are concerned about CWD and its impacts	+2*
3	Elk and deer are important to me as part of a larger landscape.	+2
12	Government organizations have the most significant role in actively managing CWD.	0*
9	Elk and deer populations are already too low.	0*

	Consensus Statements	
22	Education on CWD is important.	+3
19	CWD management should fit within the national CWD management strategy.	+2
17	CWD management should transcend boundaries	+1
5	CWD is part of a larger problem.	0
9	Elk and deer populations are already too low.	-1
16	Management decisions should be exclusively based on science.	-3

that while stakeholders may understand the problem of CWD to be ecological in nature, they may not see ecologically-oriented solutions, such as landscape management, as useful. This factor emphasized statements about developing management plans based on CWD management attempts elsewhere (20), involving impacted community members (21), and educating the public (22). Of the six participants who mapped to this factor, three were involved with the same NGO, and the other three were an RM representative, a landowner, and the researcher. Only one of them also mapped to the *Ecology & Information* factor.

3.4.2.2 Government Leadership

This factor is neatly summed up by one participant quote: "Government organizations have to take a lead role in actively managing CWD because voluntary actions don't seem to be working. Regulations need to be put in place." It views CWD as a management problem which can be resolved through traditional government mechanisms and regulation. Although this factor encourages community involvement in the development of management (11, 13), the emphasis is on government leadership and regulation (12, 13). Two of the three participants who mapped to this factor also mapped to the *Management Responsibility* problem factor, and this factor seems to address that factor's problem of diffuse responsibility and uncertainty by defaulting to government solutions. The three participants who mapped to this factor were an outfitter, a government employee, and a First Nations participant.

3.4.2.3 Risk Management

This factor places a premium on solutions to CWD which can control the spread of the disease, viewing CWD as a disease problem best addressed by preventing the disease from spreading further, rather than as a problem which is endemic. This factor emphasizes the

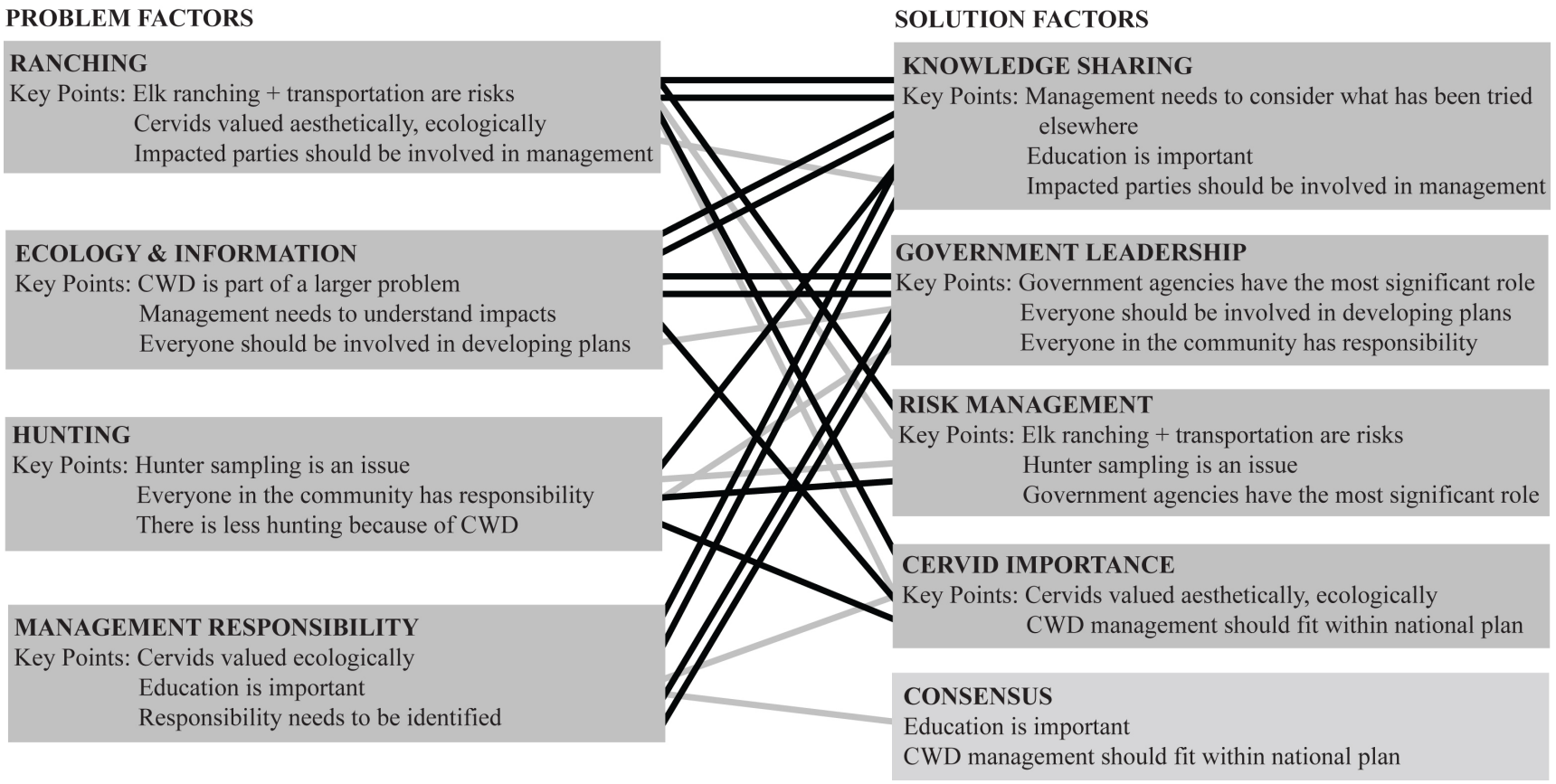

Figure 3.1. Connections between problem and solution factors drawn from Q-sorts about stakeholder perspectives on CWD. The movement of stakeholders is illustrated in black; the movement of key statements of agreement is illustrated in grey. Consensus statements for problem factors are not shown because there was no positive consensus amongst problem factors.

minimization of risks, particularly those associated with ranching and transport (25, 26), and the importance of hunter sampling (24). This factor was also defined by what it disagreed with: the statement "For effective management, science should be better at engaging with laypeople" (18). Two participants mapped to this factor, both from RMs in Manitoba. This is the only province-specific factor, and it is notable because the solutions this factor supports are used to prevent the spread of CWD and monitor its extent, which is especially valuable in areas where CWD is absent. One of the participants on this factor also mapped to the *Ranching* factor in the problem definition sort, which bears some similarity to this factor.

3.4.2.4 Cervid Importance

This factor interprets CWD solutions as primarily about elk and deer, not broader ecological context. It also does not emphasize any statements about community involvement in management. In this way it is similar to the *Ranching* problem factor, which one of its adherents also mapped to. This factor favored statements about the importance of elk and deer (1, 2), and emphasized management within the context of a national management strategy (19) as well as the significance of elk ranching (25). It also ranked the statement about farmer concern for CWD (8) higher than any other factor, possibly due to participants understanding elk ranchers to be farmers. Both participants who agreed with this factor were hunters, and one was also a government employee.

3.4.2.5 Consensus Statements

Factor analysis found several consensus statements in the solutions sorts, spanning from universally agreed upon statements to universally disagreed with statements. The most universally disagree with statement, "Management decisions should be exclusively based on

science," tended to provoke a strong reaction; one participant wished to throw it out entirely and proceed on the Q sort without it. The more positive consensus statements supported education as a solution (22) and indicated that CWD management should fit within the national CWD management strategy (19) and transcend boundaries, provincial or otherwise (17). Consensus on support of the national CWD management strategy is notable because several participants indicated that they were not sure as to the precise nature of this strategy or did not know that there was a national CWD management strategy. Consensus in support of this strategy, despite those significant knowledge gaps, suggests a general trust in governmental management of CWD, or at the very least a desire for government management. Consensus statements indicate that education is a key action all factors agree upon, and that all factors also agree that the national strategy should provide the framework for CWD management.

3.4.3 Problem-Solution Linkages

Although there appear to be some similarities between factors from the two sorts, we found no factor from the problem definition sort to be completely predictive of a solution identification factor; that is to say, participants were not grouped into the same cohorts for the problem and solution sorts (Figure 3.1). This indicates that the framework participants use to understand CWD as a problem does not have a strong impact on what they perceive as ideal solutions.

As participants moved from problems towards solutions, one solution factor encompassed participants from all four problem factors: *Knowledge Sharing*, which was also the most common solution factor. The other three solution factors only overlapped with two factors: the *Cervid Importance* factor merges participants from both the *Ranching* and the *Ecology &*

Information factors, while the *Government Leadership* factor is affiliated with *Ecology & Information* and *Management Responsibility* and *Risk Management* drew participants from *Ranching* and *Hunting*. The limited overlap here suggests that there may be small connections between problem and solution sorts even if no factors are cleanly connected; a more extensive survey may be able to clarify this further, as more participants might allow for drawing stronger linkages between problem and solution sorts.

When we ran factor analyses including all the sorts for both problem and solution factors, no clear factors emerged. The tangled results seem to provide further indication that problem and solution factors are not strongly connected.

3.4.4 Atypical Sorts

Of the three atypical sorts, two adhered to factors already established. The participant from the SK workshop, a landowner, produced a sort that aligned well with the *Ecology & Information* problem definition factor, although this sort also emphasized a unique statement developed at that workshop: "People in this area aren't scared of CWD." This participant's solution identification sort was similar to the *Knowledge Sharing* factor, although it emphasized hunter sampling more than was the norm in that factor. The landowner from the MB workshop appeared to have the most in common with the *Hunting* problem factor, although this sort exhibited a unique tendency to emphasize farmer concern about CWD. This participant's sort hewed closely to the *Cervid Importance* solution factor.

The third atypical sort came from a First Nation participant in Manitoba who developed several unique statements and produced sorts favoring those statements, which emphasized First Nations' involvement in CWD management and planning and the importance of elk and deer for

subsistence hunting and traditional uses. “I think what I would like to see is statements made from people who understand First Nations sovereignty, indigenous sovereignty, their rights to the elk not only as a food source but as a resource for products such as clothing or medicine,” this participant noted when asked about gaps in the concourse; statements to reflect those gaps were developed and used for these sorts. These sorts bore similarities to the *Management Responsibility* problem factor and the *Government Leadership* solution factor, but the importance of the participant’s role as a First Nations member and leader set them apart; it was clear that this was the central lens through which this participant viewed CWD problems and solutions.

3.4.5 External Factors

Through discussion with participants, some gaps in the concourse emerged. The most significant of these was the absence of a statement about subsistence or sustenance hunting in the concourse. Several participants, both First Nations and otherwise, mentioned that the most important role of elk and deer in their lives was as a food source. This was central to the First Nations perspective, which was absent from the original concourse due to difficulties with participant recruitment. Issues of First Nations sovereignty were also noted. One participant who worked for First Nations government noted the importance of duty of consult, saying:

> “First and foremost...we protect treaty rights, so in any type of things that we do we always have to consider that treaty right and access to hunting as significant. It’s not the responsibility of First Nations in terms of the management strategies, but they always want to be participants and in a lot of cases they aren’t. The government may develop a national strategy in terms of their significant role in managing CWD, but they also have to have First Nations involvement in that legislation or management activity if it effects their treaty rights.”

The importance of incorporating a First Nations perspective also emerged elsewhere. During the workshop in Saskatchewan, a new statement was developed about sample collection: “If heads

are sampled, it needs to be complete--including First Nations." One First Nation participant noted that First Nations may be interested in participating in head sampling if there was a greater perceived benefit, but at this point he didn't think participation was common amongst First Nation hunters. Both First Nations and non-First Nations hunters

Another absence that was notable is that of representatives from two key industries impacted by CWD: ranchers and outfitters. Ranching emerged as a risk factor during workshops, however, no ranchers were present to discuss their understanding of the implications CWD has for their industry, and the role ranching might play in CWD management going forward. Although one outfitter participated in a workshop, the implications of CWD for outfitting were not plumbed at all, and did not emerge in the concourse or in later discussions, perhaps because no outfitters were interviewed during concourse development.

Statement interpretation played a role in how Q sorts were completed. In Saskatchewan, statements predicated on assumptions about the presence or absence of CWD produced a variable response; some participant's interpreted CWD's presence within Saskatchewan as presence in their region, even if they were aware CWD had not been recorded in their immediate area, while other participants drew more restrictive boundaries around their region and considered the disease to be absent. The issue of scale and boundary is notable, as no Manitoban participants felt that CWD was present in their region because it was near the Manitoba border. It should be noted that personal interpretations like this are central to Q methodology, given that subjects are expected to complete Q sorts with respect to their internal frame of reference (McKeown & Thomas 1988).

3.5 Discussion

3.5.1 Perspectives on CWD Problems

The problem factors we identified for CWD help illustrate the various ways in which CWD may be interpreted as a risk. Ulrich Beck writes that "the actual social impetus of risks lies in the projected dangers of the future" (1992). The fact that problem sorts sometimes emphasized solution statements suggests that participants may view CWD as a technical problem rather than a risk; there is no projected danger, and instead an emphasis on deciding between techniques to resolve the problem. The *Ranching* factor, for example, placed its primary emphasis on human behavior which contributed to the spread of CWD and a secondary emphasis on the importance of elk and deer; in the same way, the focus of the *Ecology & Information* factor was lack of knowledge, the *Hunting* factor emphasized hunter participation in head collection programs, and *Management Responsibility* saw CWD as a problem of responsibility allocation, although this factor also emphasized the importance of deer and elk as part of the landscape. All of these frame the problem of CWD as a question of resolving technical problems rather than as a potential threat. This may not be a bad thing; it does, however, indicate that CWD lacks what Beck calls "social impetus."

One of the notable findings of the social research that occurred following Wisconsin's aggressive CWD management was that hunters became less interested in participating as their perception of CWD as a significant risk lessened (Holsman *et al.* 2010). This dropping off of risk perception occurred as CWD became more prevalent and stakeholders gained more experience with the disease. CWD was first found in farmed elk in Saskatchewan in 1996, sixteen years prior to the inception of this project. It would follow that stakeholders have been marginally aware of CWD for at least this long; their manifest uncertainty speaks to both a lack of concern

and a lack of cause for concern. For example, the concourse for this study included two statements about the possibility that elk and deer populations had shifted in recent years: “Elk and deer populations are already too low,” and “There are more elk on the landscape in smaller groups now because of rural depopulation.” The latter was developed at the Manitoba workshop. During individual sorts, stakeholders tended to respond with uncertainty to these statements. One participant noted that sometimes he noted more deer on his drives home, but that could just as easily be attributed to driving home at different times of day as to a shift in cervid numbers. A landowner who was interviewed during concourse development expressed the sentiment that hunting activity had dropped off due to CWD (this became statement 10). Only one factor agreed with this statement, but, tellingly, no factors strongly disagreed with it--in most sorts it wound up somewhere in the uncertain middle. Taken together, this ambivalence suggests that stakeholders have not seen significant impact from CWD over the past years, in much the same way stakeholders in Wisconsin did not see the impact of the disease. This was confirmed by participating stakeholders, most of whom said they had observed no changes in cervid populations since CWD’s emergence. And, in a similar way, the perceived lack of impact has translated into CWD being perceived as a relatively minor risk.

3.5.2 Perspectives on CWD Solutions

Several consensus statements emerged from the CWD solutions sorts. Most notably, there was consensus in support of three statements: “Education is important,” “CWD management should fit within the national CWD management strategy,” and “CWD management should transcend boundaries.” Of the three, “Education is important” received the strongest positive weighting.

The universal acceptance of the importance of education could be interpreted in multiple ways: participants may feel that education will make CWD management more effective, perhaps encouraging stakeholder participation in things like head collection programs. Alternatively, stakeholders may feel like there is a broader vacuum of CWD knowledge, and increasing knowledge through education will provide guidance for future management. "I have very little knowledge of CWD, other than being aware of its importance on the prairies as a disease that needs to be investigated," one participant noted. The statement about education may be too broad to ascertain what participants' precise interpretations were. It seems probable that each factor envisages using education to further their own ends. The *Knowledge Sharing* factor, which also emphasized the importance of making management decisions based on what had been tried elsewhere, might like to use education to help stakeholders and managers learn about what management has been undertaken elsewhere, while a factor like *Risk Management*, which places more weight on issues like cervid transportation and hunter sampling, might like to see education used to increase hunters' knowledge of the disease and participation in activities like head collection programs. Regardless, the consensus in support of education suggest it is viewed as a panacea. As one participant on the *Knowledge Sharing* factor said: "Whenever there's a problem, education is <u>always</u> the answer."

The other two consensus statements were weighted less strongly than the statements about education, but they may twine together, because a national management strategy should, by its very nature, transcend provincial boundaries. The support for the national management strategy could be attributed to the participation of federal, First Nations, and provincial government employees in this study, but it is especially notable in light of the fact that several of

the participants who were not affiliated with government said they did not know what Canada's National CWD Control Strategy was, or that such a thing existed. Consensus around these statements could indicate either a generalized support of government management or simply support of the idea that CWD should be addressed on a national level, not just a province-by-province basis. Both options appear to be rooted in a certain degree of governmental trust, at least in relation to CWD management; however, this trust could also be attributed to an uncertainty that perceives government management as a default solution, so it should not be assumed that increased government management activity would be immediately welcomed. If the stakeholder support for a National CWD Control Strategy was because of a stakeholder wish for national CWD management, that could be attributed to the current regulatory status of CWD in Canada. The National CWD Control Strategy has not been implemented, CWD management in Canada is currently divided between provincial and federal agencies, in addition to being shared between agencies managing wildlife and those handling game farming (i.e. the Canadian Food Inspection Agency (CFIA)) (Kahn *et al.* 2004).

Research in the United States found that the majority of hunters in eight surveyed states trusted wildlife agencies to manage CWD, but "hunters who perceived higher CWD risks were less likely to trust the state wildlife agency to manage CWD and believe public information provided by this agency" (Vaske 2010). This supports indications that stakeholders in Canada consider CWD low risk. These results are also paralleled by research on wildlife damage management and policy in the United States, which found that "citizens want a role in wildlife damage management policy formation, but respect wildlife management professionals judgment in specific management situations;" specifically, citizens did not think public opinion was a

major factor in selecting management techniques, assuming a method "poses little risk to humans, causes little suffering to animals, and is effective in reducing damage" (Reiter *et al.* 1999). One notable difference from this study was that in the U.S. state leadership was favored over the federal leadership that was emphasized in our results (Reiter *et al.* 1999). This could be attributed to a variety of factors, including the fact that a National CWD Management Plan was discussed with participants in this study (because it appeared in the concourse) and thus might be foremost on their minds, or general differences in attitude between the U.S. and Canada.

Beyond the consensus statements, there are subtle distinctions between the four solution factors. The *Risk Management* factor, which was supported exclusively by participants from Manitoba, indicates a difference in how residents of a region where CWD is absent approach CWD management, placing more emphasis on the reduction of risk through management methods, presumably towards the end of preventing CWD's arrival in their province. Only two Manitoban participants adhered to this factor; the province is not a monolith. However, the absence of participants from Saskatchewan here, especially when the other three factors promote more nebulous management actions, suggesting more uncertainty about management when CWD is present.

The *Cervid Importance* factor is unique as the only factor that does not emphasize community involvement in management to some degree, instead emphasizing the importance of elk and deer. All of the other factors supported some form of community involvement with management. The lack of emphasis on community involvement here may suggest a fundamental rift between the factors, however, two of the participants from this factor mapped to problem factors (*Ranching* and *Ecology & Information*) that did support statements about community

involvement. Therefore, it seems more likely that, rather than opposing community participation in management, this factor just does not consider it the most important aspect of developing CWD solutions. That is still a notable difference from the other three factors.

The *Government Leadership* and *Knowledge Sharing* factors can be interpreted as emphasizing two different sides of the consensus statements. *Government Leadership* emphasizes the governmental role in and responsibility for leading CWD management--aligning with the consensus statement about working within a national management plan--whereas *Knowledge Sharing* emphasizes solutions rooted in increased knowledge and education.

3.5.3 Research Gaps

The results presented here begin to offer an introductory overview of stakeholder perspectives on CWD in Canada; however, they are far from complete. This research could benefit from more extensive stakeholder representation, perhaps through workshops aimed at specific groups such as First Nations, cervid ranchers, and outfitters. While there was some representation of First Nations and outfitters in this project, further work with these groups, as well as cervid ranchers, could offer unique insights into CWD and its management that we have not fully plumbed. All three of these groups use cervids in ways that could cause them to perceive CWD as a greater risk, influencing their perspectives on CWD management in turn. Some study participants also indicated that the ranching industry should be a leader in CWD management due to its role in the spread of CWD; without surveying cervid ranchers, it is difficult to know whether this is possible or what it might look like.

The absence of outfitters and cervid ranchers amongst the participants may skew the results of this research away from economic interpretations of CWD problems and solutions, and

may also account for the lack of a strong imperative amongst stakeholders to take leadership roles in CWD management themselves. It is possible outfitters or cervid ranchers may consider CWD a greater threat and wish to be involved with management in a greater capacity than the stakeholders who did participate.

Furthermore, this study was carried out in specific regions, and surveys of stakeholders in different regions of Saskatchewan and Manitoba, or in Alberta, could produce different responses and perspectives. It should be noted that the use of Q methodology means that even with a lack of breadth due to the small sample size the data we have gleaned offers a depth of insight into the perspectives that were identified. However, due to the relatively small sample size and incomplete survey of stakeholder groups, this research is best viewed as an introduction to stakeholder perspectives rather than a comprehensive survey of all the stakeholder perspectives which may exist.

3.6 Conclusions

Results of this study indicate that CWD management in Canada exists in a complex social landscape, colored by uncertainty and ambivalence. There are a few implications for management to be found here. Firstly, it seems that most stakeholders wish to see government leadership for CWD management; however, there is also a desire for stakeholder consultation. And there is value to be found in stakeholder consultation: one notable example from this study ties to recent developments in Saskatchewan. Over the course of this research, participants in Manitoba and Saskatchewan expressed concern about the lack of participation in the head collection programs used to test deer and elk for CWD and monitor its spread and prevalence. Interviews with participants indicated that hunters may not be participating due to lack of

incentives, difficulty and inconvenience associated with participation, and concern about what would happen to their deer if they were submitted to the government for testing. Participants felt more should be done to encourage participation in these programs, and that low participation was a problem; statements about this were developed in both the Manitoba and Saskatchewan workshops. These concerns, voiced in the fall of 2012, were prescient. In the spring of 2013, funding for Saskatchewan's provincial CWD monitoring program was cut due to lack of participation (CCWHC 2013). Instead, hunters may have heads tested themselves at a cost of 120 CAD. If hunters did not participate in a free program, it is unlikely they will participate in one that imposes such a cost. The loss of this program is also notable as one of the goals of Canada's National Chronic Wasting Disease Control Strategy is "Early detection of CWD in cervid populations...to maximize the effectiveness of control measures and minimize costs and economic losses, achieved through vigilant CWD surveillance supported by improved scientific methods and facilities" (2005). Without head collection and hunter participation, early detection of CWD's spread will become increasingly difficult. However, participants in this study indicated that increased hunter participation would be unlikely unless there was some sort of incentive for participation--precisely the opposite of Saskatchewan's new situation, which imposes costs rather than incentives.

That the loss of Saskatchewan's head collection program *is* a loss is reinforced by our finding that stakeholders were focused on CWD solutions which were spearheaded by government agencies. This would seem to indicate that CWD lacks a strong impetus for independent action from stakeholders. However, stakeholders did exhibit an interest in being

involved with CWD management, and insights like their comments on the head testing program could be valuable to government practitioners.

The stakeholder desire to see government leadership on CWD may be due to feelings of uncertainty from stakeholders and the assumption that government leadership is the best default solution, rather than a complete trust if government. If this is the case, it is likely that increased management activity from government agencies could elicit stronger reactions from stakeholders or education about CWD could lead to greater stakeholder interest in and involvement with management.

Education, which stakeholders had consensus about as a solution, may be part of this leadership; however, it is unclear whether education is actually capable of being the panacea stakeholders identified it to be. Research has found that there is not a clean linear connection from increased knowledge to action, as environmental education sometimes assumes (Hungerford & Volk 1990). Despite that, education on CWD may have some value in encouraging action, as environmental education research has also found that knowledge of the issue and knowledge of "those courses of action which are available and which will be most effective in a given situation" are important prerequisites for action (Hines *et al.* 1987). Education may be used to resolve some of the uncertainty stakeholders have about CWD, although it should not be assumed that this will result in action. Keeping stakeholders apprised of new developments with CWD and its management should ensure that, at the very least, stakeholders can make informed decisions about how they wish to participate. An example of this emerged from our Q sorts--one of the consensus statements, contributed by a wildlife manager, emphasized the role of predators in CWD management (14). This statement was based

on research which has found that predators preferentially take CWD infected elk, even before symptoms manifest (Sargeant *et al.* 2011). This was a statement that the factors tended to be indifferent towards, with the *Ranching* problem factor giving it a strongly negative ranking and the *Government Leadership* solution factor loading it slightly positively. This response could be attributed to either a negative attitude towards predators or a lack of knowledge about the potential for predators to contribute to CWD control.

It should also be noted that managers can have their own blind spots, and stakeholders may have knowledge that, when shared with managers, can help managers understand what they can expect should they employ management options--such as head collection programs--that are predicated on stakeholder involvement. Stakeholders may not know everything about CWD, but that can be remedied. However, they certainly know themselves, and may be able to offer novel insight about community perspectives about potential CWD management activity if invited to exchange knowledge with wildlife managers. That said, leadership is necessary for stakeholder involvement and knowledge exchange with wildlife managers to occur around CWD.

CHAPTER 4: DISCUSSION

4.1 Summary of Results

The stated objectives of this research were to understand how stakeholders frame CWD as a risk, what preferences stakeholders have for CWD management, and whether adaptive governance is a useful framework for Canadian CWD management. Using Q methodology, four problem and four solution factors associated with CWD management were identified and described. Problem factors emphasized CWD as a problem of human behavior, CWD as a problem within a broader ecological context, CWD as a problem due to hunters and hunter sampling, and CWD as a question of responsibility allocation. Solution factors suggested increasing knowledge of and education about CWD, government leadership for management, managing CWD transmission risks, and respecting the importance of cervids. Problem factors and solution factors were not found to be strongly connected; nor were there clear associations between stakeholder affiliation and problem or solution factors. There was significant common ground amongst the solution factors, encouraging education and the development of CWD management within the framework of a national management strategy. Stakeholder seem to wish to be consulted about CWD management, but would like to see management undertaken under the auspices of government leadership.

4.2 Relevance of Results

4.2.1 CWD Management in Canada

My research found some alignment between stakeholder concerns and the goals of Canada's National CWD Control Strategy: preventing the further emergence of CWD, detecting new emergence of CWD, planning a response to CWD, managing CWD, educating and training

wildlife disease specialists, and communication to coordinate and collaborate on the achievement of these goals (Bates *et al.* 2005). Furthermore, there was consensus among stakeholders that CWD management should fit within the national management plan, although it should be noted that several stakeholders also admitted that they did not know what the National CWD Control Strategy looked like. This trend indicates a generalized trust in government leadership for CWD management. However, stakeholders still wished to be consulted or at least included in management activity. This consultation could take a range of forms, ranging from the duty to consult with First Nations to simply releasing management plans to the community in an accessible format. And stakeholder consultation could likely be valuable; the stakeholders who participated in this study expressed concern about lack of hunter participation in head collection programs shortly before Saskatchewan's monitoring program was cut due to a lack of participation, and made suggestions that such a program should be incentivized to encourage participation (CCWHC 2013). With this cut, the opposite has occurred due to a combination of low stakeholder interest and government budgeting.

Prioritization like that which is occurring around CWD management is not unusual. The literature on path dependency notes that "when choices must be made, the option most likely to be chosen is that which most closely resembles existing practice or previous choices" (Kirk *et al.* 2007). This can make it especially difficult to adopt new policy frameworks. Kirk, *et al.*, explored the ways in which the decisions made at "choice points" can restrict the possibility for change, and found that resource constraints had a significant impact on the ability to implement policy, noting, "the failure of the budget to fully reflect the needs of this particular policy has rendered what should have been a punctuation point in policy an incremental change, at least for

the present" (2007). Management efforts are often predicated on the prioritization of limited resources; government agencies prioritize their own management capacity to where the need is greatest and management most effective, while stakeholders prioritize time and effort based on their own personal concerns and interests. This prioritization is a natural part of decision making; however, it also makes it possible for problems to fall through the cracks due to lack of resources and low priority, and CWD shows the potential to become such an issue. The question, then, is whether CWD's low priority status is acceptable to stakeholders and managers.

We can speculate that changes like the loss of Saskatchewan's monitoring program could ultimately lead to a shift in stakeholder support of government; other changes that could result in increased stakeholder interest include an increase in perceived CWD risk or the implementation of more aggressive CWD management. Both of these emerged as key factors tied to stakeholder support of government activity in research about stakeholder opinions on CWD management in the United States, where Wisconsin's original aggressive management plan was ultimately replaced with a new plan that incorporated stakeholder participation due to dissent (Vaske 2010; Holsman *et al.* 2010). My results align well with the stakeholder research on CWD that has come out of the United States; however, the First Nations perspective in Canada emerged as distinct from the perspectives that have been surveyed thus far in the United States. First Nations and American Indian opinions should be explored further. Working with a specific First Nation or surveying elders may produce a more in-depth or nuanced picture of First Nations opinion on this matter. The importance of subsistence hunting amongst First Nations especially should not be discounted, nor should the importance of duty to consult (another uniquely Canadian aspect of this management problem) (Morellato 2008). Further work with outfitters and cervid ranchers

may also expose unique perspectives on CWD and its management that this study has not fully explored.

Continued stakeholder consultation as Canadian CWD management develops may be the most important actionable result of this research. The emphasis on education suggests that stakeholder consultation should be coupled with attempts to keep stakeholders informed about CWD and CWD management options. Although education may not be effective for mobilizing inert stakeholders, effective education would help resolve stakeholder uncertainty about CWD, and better informed stakeholders may have more useful insight for managers, as well as greater interest in participating in management activities. Thus, management agencies may find it valuable to couple their activities with programs intended to educate stakeholders about both CWD and what is being done to manage it. The precise nature of this education should be calibrated to the stakeholder groups participating and the values they derive from elk; for example, hunters may have quite different interests and concerns from cervid ranchers, who might differ again from landowners or community members interested in elk as part of their region's larger landscape.

To further understand stakeholder perspectives on CWD management in Canada, surveying the stakeholder groups that were not incorporated into this project is an important step. Based on the experience gleaned from this study, it might be best to initiate this by reaching out to already established stakeholder groups, and going to meet stakeholders in their own places. First Nations who participated in this study indicated that they would like to see people come into their communities and organize educational workshops on CWD; in a similar vein,

professional organizations of outfitters or cervid ranchers might be the best place to begin reaching out to these groups.

4.2.2 CWD Management & Adaptive Governance

As it becomes increasingly common to incorporate stakeholders into natural resources management, Canadian CWD management provides an example of a management problem where adaptive governance or co-management do not seem to be a viable solutions. Stakeholders are relatively ambivalent towards CWD and comfortable with government responsibility for management decision making. Ruitenbeek and Cartier's research concludes that adaptive co-management (ACM) cannot be imposed, hypothesizing that ACM will emerge naturally with increasing complexity; imposted ACM may fail due to a mismatch between system complexity and management; and, thirdly, that premature introduction of ACM may cause system failure (2001). There is no indication that CWD management in Canada is ripe for ACM or adaptive governance emergence.

To reinforce the mismatch between CWD and ACM, consider Armitage *et al.*'s ten conditions for successful ACM (2009). The traits which refer to the resource itself describe a "well-defined resource system," "small-scale resource use contexts," and "reasonably clear property rights" (Armitage *et al.* 2009). If we consider cervid populations to be the resource in this instance, it could be argued that the resource is appropriate for ACM. However, the traits that describe management options are less aligned, specifically "access to adaptable portfolio of management measures," which is something CWD management lacks due to the fairly limited suite of management options available at this point (2009). With regards to traits related to capacity, CWD management in Canada does have "national and regional policy explicitly

supportive of collaborative management efforts" and "openness of participants to share and draw upon a plurality of knowledge systems and sources," but lacks "key leaders prepared to champion the process," and appears to lack the "commitment to support long-term institution-building process, provision of training, capacity building, and resources for local-, regional- and national-level stakeholders" (2009). The absence of key leaders among stakeholders seems to be central, in that there is currently no impetus to develop adaptive governance, regardless as to whether or not it has the potential to be effective for CWD management. Adaptive governance often grows out of a mutual desire for collaboration or resolution of a shared goal; in the absence of that, there is no reason for leaders to emerge and champion the process (Brunner *et al.* 2005). The combination of uncertainty about management options and the lack of leadership--perhaps either creating or created by a lack of conflict--means that traditional scientific management coupled with stakeholder consultation may be the best current option for this system. The precise nature of this stakeholder consultation remains nebulous; due to the lack of strong interest from stakeholders, it follows that stakeholder consultation may require support and encouragement from management entities in order to foster involvement. Furthermore, "consultation" will likely need to include a range of activities, including educating stakeholders in order to drum up interest and allow them to make informed judgments about CWD management. Recruiting leaders from communities impacted by CWD and partnering with relevant NGOs could also help extend activities.

4.2.3 Directions for Stakeholder Engagement & Wildlife Disease Management

The difficulties I found in applying adaptive governance to CWD can likely be found in other systems that incorporate wildlife disease. Although communities in both the Prince Albert

and Riding Mountain regions had previous instances of stakeholder involvement in wildlife disease management, these both arose around wildlife diseases that impacted livestock more significantly. At this juncture, CWD is more purely a disease of wildlife, and as such the scope of its impact is limited; this limited impact translates into limited stakeholder concern. Furthermore, CWD management in Canada lacks the level of aggression that might result in higher levels of stakeholder concern, as was seen in Wisconsin when attempts were made to reduce the deer herd significantly. When working with similar wildlife diseases--diseases that impact only wildlife species and are perceived as a relatively minor threat--wildlife managers may find that, if community engagement is to occur, the organic emergence of adaptive governance or ACM systems is unlikely. Instead, the onus for stakeholder involvement will be on managers, not stakeholders. This may mean providing incentives for participation in management or monitoring activities and communicating well with stakeholders.

It should be acknowledged that social systems are distinct, and this research was strictly bounded, both regionally and by the specific nature of the disease it addresses. Future research in this area should begin by understanding the places where a specific wildlife disease intersects with social context. The system around CWD in Canada only met some of Armitage *et al.*'s conditions for successful ACM, and no signs of ACM emergence were found (2009). Fitting a situation within this framework could prove a useful tool for further investigations into stakeholder involvement with wildlife disease management. In situations where ACM is unlikely to emerge, researchers may find, as I did, that participant recruitment is also difficult due to low levels of stakeholder engagement. In these instances, research processes should be incentivized

and easy to participate in, mimicking the way managers might expect to encourage stakeholder participation in issues that are of low priority.

It might be argued that low stakeholder engagement is a reason not to undertake research like this at all; however, especially when stakeholder participation has a role in management, understanding the perspectives that exist around stakeholder engagement can be a valuable tool for wildlife managers to understand stakeholder concerns and expectations about the nebulous issue of wildlife disease, and can help managers understand how best to enact management that involves stakeholders. Perhaps the most important thing is to find a rounded set of stakeholders representing a range of groups, with special attention to groups that may be impacted by the disease. Participation from the managers themselves also provides insight.

4.3 Researcher Reflections

This research project has been iterative, but in many ways even its complete form is only an initial iteration--there are many places where the work might be refined further. What I mean to say is that over the course of this research I have learned in ways small and large, and I would not do things the same if I were to do them again. Although a researcher, I have also been a student of this project, and it has taught me, not just about CWD management but also about the process of conducting research.

There is the essential problem of participant recruitment and small sample size; however, that has been discussed already and is perhaps not the most fertile grounds for building potential improvements. At their essence, the problems encountered here have to do with the importance of building connections with communities; I regret to say that as I completed this research, I

found I was only beginning to really know some of the communities I was working with, and they were only beginning to open up both to me and the to the issue of CWD.

I believe an expanded set of statements for the Q sorts could have produced a more refined and nuanced set of perspectives; this could have been achieved by spending more time on concourse development and recruiting a broader range of participants during the concourse development phase of the research. Some of the gaps that emerged later in the research process, particularly when working with First Nations participants, are a direct result of gaps in the concourse. A larger concourse could have captured a broader range of perspectives.

This research also initiated with the intent of surveying only what stakeholders knew, and not providing extensive information about CWD prior to the research process for fear of bias. As I interacted with stakeholders, especially during individual Q-sorts, I came to believe that providing a certain amount of information was necessary to the process of conducting this research. Furthermore, many stakeholders expressed an interest in learning more about CWD, and providing a short educational seminar during research workshops may have helped entice participants. There is, of course, the matter of whether such information might bias participant responses, but I think, if appropriately framed, educational material may have helped stakeholders better frame their own understandings of CWD risk and management, providing a firm foundation on which stakeholders might build their perspectives.

4.4 Conclusions

This research illustrates current perspectives on CWD risk and management in Saskatchewan in Manitoba; its results suggest that, while there are a range of stakeholder perspectives on CWD, these perspectives are united in their desire for more education and

government leadership in management. I conclude that there are two reasons for relatively limited stakeholder concern about CWD: a limited suite of management options, and the perception that CWD is not a significant threat to human health or cervid populations. This context means that Canadian CWD management is currently unsuited to collaborative governance options that require a high degree of stakeholder leadership. However, stakeholder consultation and education about CWD and its management options still have a place in Canadian CWD management, especially as changes to either risk perception or management options could result in a situation where stakeholder interest is more pronounced. As knowledge of CWD management options and CWD itself increases, it would be wise for managers to continue to encourage stakeholder participation and monitor the barometer of stakeholder opinion for shifts in the social context which surrounds this disease.

LITERATURE CITED

Ansell, C. and A. Gash. 2007. Collaborative governance in theory and practice. Journal of Public Administration Research and Theory 18: 543-571.

Argyris, C. 2002. Double-loop learning, teaching, and research. Academy of Management Learning & Education 1(2): 206-218.

Armitage, D. R., R. Plummer, F. Berkes, R. I. Arthur, A. T. Charles, I. J. Davidson-Hunt, A. P. Diduck, N. C. Doubleday, D. S. Johnson, M. Marschke, P. McConney, E. W. Pinkerton, and E. K. Wollenberg. 2009. Adaptive co-management for social-ecological complexity. Frontiers in Ecology and the Environment 7: 95-102.

Bartelt, G. A., D. Joly, J. Langenberg, K. McCaffery, G. Mitchell, J. D. Pardee, R. E. Rolley, M. D. Samuel, K. A. Thiede, T. R. Van Deelen, and W. Vander Zouwen. 2003. Environmental impact statement on rules to eradicate chronic wasting disease from Wisconsin's free-ranging white-tailed deer herd. Available from http://wildpro.twycrosszoo.org.

Bates, L., V. Crichton, L. Forsythe, G. Hauer, K. Kingdon, W. Lees, T. Leighton, R. Lind, J. McLane, B. Patterson, B. Pearl, M. Pybus, H. Reynolds, T. Shury, S. Stephens, T. Whiting and P. Zimmer. 2005. Canada's national chronic wasting disease control strategy. Available from http://www.ccwhc.ca/.

Beck, U. 1992. Risk society. London: SAGE Publications.

Belay, E. D., R. A. Maddox, E. S. Williams, M. W. Miller, P. Gambetti, and L. B. Schonberger. 2004. Chronic wasting disease and potential transmission to humans. Emerging Infectious Diseases. 10: 977–984.

Belcher, K., and J. Lokken. 2008. Saskatchewan cervid game farming economic analysis. Appendix A in P. C. James. Both sides of the fence: A strategic review of chronic wasting disease management costs and benefits. Regina: University of Regina.

Beringer, J., L. P. Hansen, J. J. Millspaugh, and T. Meyer. 2003. The statewide surveillance for detecting chronic wasting disease in wild white-tailed deer in Missouri. Wildlife Society Bulletin 31: 873-881.

Berkes, F. 2009. Evolution of co-management: Role of knowledge generation, bridging organizations, and social learning. Journal of Environmental Management 90: 1692-1702.

Bishop, R. C. 2002. The economic effects in 2002 of chronic wasting disease (CWD) in Wisconsin. Staff Paper No. 450. Madison WI: University of Wisconsin.

Bollinger, T., P. Caley, E. Merrill, F. Messier, M. W. Miller, M. D. Samuel, and E. Vanopdenbosch. 2004. Chronic wasting disease in Canadian wildlife: An expert opinion on the epidemiology and risks to wild deer. Saskatoon: Canadian Cooperative Wildlife Health Center.

Boyle, M, J. Kay, and B. Pond. 2001. Monitoring in support of policy: an adaptive ecosystem approach. In Encyclopedia of Global Environmental Change, Vol. 4, T. Munn, Ed. pp. 116–37. New York: Wiley.

Brook, R. K. 2009. Historical review of elk–agriculture conflicts in and around Riding Mountain National Park, Manitoba, Canada. Human-Wildlife Conflicts 3: 71-87.

Brook, R. K. and S. M. McLachlan. 2006. Factors influencing farmers' concerns regarding bovine tuberculosis in wildlife and livestock around Riding Mountain National Park. Journal of Environmental Management 80: 156-166.

Brown, R. D. and S. M. Cooper. 2006. The nutritional, ecological and ethical arguments against baiting and feeding white-tailed deer. Wildlife Society Bulletin 34: 519-524.

Brunner, R. D., T. A. Steelman, L. Coe-Juell, C. M. Cromley, C. M. Edwards, and D. W. Tucker. 2005. Adaptive governance: integrating science, policy, and decision making. New York: Columbia University Press.

Brunner, R. D., C. H. Colburn, C. M. Cromley, R. A. Klein and E. A. Olson. 2002. Finding common ground: Governance and natural resources in the American west. New Haven: Yale University Press.

Canadian Food Inspection Agency. 2013. Chronic wasting disease. Available from: http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/cwd/if-your-animals-may-be-infected/eng/1330188848236/1330189018195.

CCWHC. 2013. Chronic wasting disease hunter surveillance program cut in Saskatchewan. Available from: http://www.healthywildlife.ca/?p=2588.

CCWHC. 2011. A proposal for Canada's national chronic wasting disease control strategy. Available from http://www.ccwhc.ca/.

Carlsson, L. and F. Berkes. 2005. Co-management: Concepts and methodological implications. Journal of Environmental Management 75: 65-76.

Conner, M. M., M. R. Ebinger, J. A. Blanchong, and P. C. Cross. 2008. Infectious disease in cervids of North America: Data, models, and management challenges. Annals of the New York Academy of Science 1134: 142-178.

Conservation Manitoba. 2012. News Release: Rapid response will protect Manitoba elk from chronic wasting disease: Mackintosh. 12 March 2012.

Cooney, E. E. and R. H. Holsman. 2010. Influences on hunter support for deer herd reducation as a chronic wasting disease (CWD) management strategy. Human Dimensions of Wildlife 15: 194-207.

Diefenbach, D. R., C. R. Rosenberry, and R. C. Boyd. 2004. Efficacy of detecting chronic wasting disease via sampling hunter-killed white-tailed deer. Wildlife Society Bulletin 32: 267-272.

Douglas, G. 2011. Perils of chronic wasting disease regulation. Management of chronic wasting disease in Canada: Past practices, current conditions, current science, future risks, and options. CCWHC. Available from http://prioninstitute.ca.

Fenichel, E. P., and R. D. Horan. 2007. Jointly determined ecological thresholds and economic trade-offs in wildlife disease management. Natural Resources Modeling 20(4): 511-547.

Folke, C., T. Hahn, P. Olsson and J. Norberg. 2005. Adaptive governance for social-ecological systems. Annual Review Environmental Resources 30: 441-473.

Gillin, C. M., G. M. Tabor, and A. A. Aguirre. 2002. Ecological health and wildlife disease management in national parks. In A. A. Aguirre, R. S. Ostfeld, G. M. Tabor, C. House and M. C. Pearl, Eds., Conservation Medicine: ecological health in practice. New York: Oxford University Press.

Goodman, L. A. 1961. Snowball sampling. The Annals of Mathematical Statistics 32(1): 148-170.

Hardin, G. 1968. The tragedy of the commons. Science 162: 1243-1248.

Heberlein, T. A. 2004. Fire in the Sistine Chapel: How Wisconsin responded to chronic wasting disease. Human Dimensions of Wildlife 9: 165-179.

Hines, J. M., H. R. Hungerford, and A. M. Tomera. Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. The Journal of Environmental Education 18: 1-8.

Holling, C. S. 1978. Adaptive environmental assessment and management. Caldwell NJ: Blackburn Press.

Holsman, R. H., Petchenik, J., and Cooney, E. E. 2010. CWD After "the Fire": Six Reasons Why Hunters Resisted Wisconsin's Eradication Effort. Human Dimensions of Wildlife 15(3): 180–193.

Hungerford, H. R., and T. L. Volk. 1990. Changing learner behavior through environmental education. Journal of Environmental Education 21: 8-22.

Jones, G. 2009. Is the management plan achieving its objectives? In Worboys, G., De Lacy, T., & Lockwood, M. (eds) Protected Area Management Principles and Practices. Oxford: Oxford University Press.

Kahn, S., C. Dubé, L. Bates, and A. Balachandran. 2004. Chronic wasting disease in Canada: Part 1. The Canadian Veterinary Journal. 45(5): 397.

Kelly, J. 2007. Communities for conservation: Creating a framework for plains bison conservation in central Saskatchewan. Master's thesis. University of Manitoba.

Kirk, E., A. D. Reeves, and K. L. Blackstock. 2007. Path dependency and the implementation of environmental regulation. Environment and Planning C 25: 250-268.

Leopold, A. 1939. Game management. New York: Charles Scribner's Sons.

Lischka, S. A., P. Shelton and J. Buhnerkempe. 2010. Support for chronic wasting disease management among residents of the infected area of Illinois. Human Dimensions of Wildlife 15(3): 229-232.

Lyon, K. M. and J. J. Vaske. 2011. Predicting hunting participation in response to chronic wasting disease in four states. Human Dimensions of Wildlife 15(3): 208-220.

Mattson, D. J., K. L. Byrd, M. B. Rutherford, S. R. Brown and T. W. Clark. 2006. Finding common ground in large carnivore conservation: mapping contending perspectives. Environmental Science and Policy 9: 392-405.

McKeown, B. and D. Thomas. 1988. Q Methodology. London: SAGE Publications.

Miller, M. W., E. S. Williams, N. T. Hobbs, and L. L. Wolfe. 2004. Environmental sources of prion transmission in mule deer. Emergent Infectious Diseases 10(6): 1003-1006.

Morellato, M. 2008. The crown's constitutional duty to consult and accommodate aboriginal treaty rights. National Centre for First Nations Governance. Available from: http://fngovernance.org/ncfng_research/maria_marletto.pdf.

Morgan, D. 2008. The SAGE Encyclopedia of Qualitative Research Methods. SAGE Publications, Inc. pp. 816–817.

Needham, M. D., J. J. Vaske, and M. J. Manfredo. 2004. Hunters' behavior and acceptance of management actions related to chronic wasting disease in eight states. Human Dimensions of Wildlife 9: 211-231.

Ostrom, E. 1990. Governing the commons: the evolution of institutions for collective action. Cambridge: Cambridge University Press.

Parks Canada. 2007. Riding Mountain National Park of Canada and Riding Mountain Park East Gate Registration Complex National Historic Site of Canada Management Plan. Available from: http://www.pc.gc.ca/pn-np/mb/riding/plan/plan1.aspx.

Petigara, M., C. Dridi, and J. Unterschultz. 2011. The economic impacts of chronic wasting disease and bovine spongiform encephalopathy in Alberta and the rest of Canada. Journal of Toxicology and Environmental Health 74:1609-1620.

Pomeroy, R. S., and F. Berkes. 1997. Two to tango: the role of government in fisheries co-management. Marine Policy 21, 465-480.

Reiter, D. K., M. W. Brunson, and R. H. Schmidt. 1999. Public attitudes towards wildlife management and policy. Wildlife Society Bulletin 27(3): 746-758.

Rhyan, J. C. and T. R. Spraker. 2010. Emergence of diseases from wildlife reservoirs. Veterinary Pathology 47: 34-39.

Rijke, J., R. Brown, C. Zevenbergen, R. Ashley, M. Farrelly, P. Morison, and S. van Herk. 2012. Fit-for purpose governance: making adaptive governance operational. Environmental Science & Policy 22: 73-84.

Ruitenbeek, J. and C. Carter. 2001. The invisible wand: adaptive co-management as an emergent strategy in complex bio-economic systems. Jakarta: Center for International Forestry Research.

Rutherford, M. B., M. L. Gibeau, S. G. Clark, and E. C. Chamberlain. 2009. Interdisciplinary problem-solving workshops for grizzly bear conservation in Banff National Park. Policy Science 42: 163-187.

Sargeant, G. A., D. C. Weber, and D. E. Roddy. 2011. Implications of chronic wasting disease, cougar predation, and reduced recruitment in elk. Journal of Wildlife Management 75: 171-177.

Schmolck, P. and J. Atkinson. 2002. PQMethod. Available from: http://schmolck.userweb.mwn.de/qmethod/.

Smith, C. B., C. J. Booth, and J. A. Pedersen. 2011. Fates of prions in soil: a review. Journal of Environmental Quality 40: 449-461.

Smith, P. 2000. Aboriginal participation in forest management: Not just another stakeholder. National Aboriginal Forestry Association. Available from: http://nafaforestry.org/pdf/stakeholder.pdf.

Shury, T., D. Frandsen, and L. O'Brodovich. 2009. Anthrax in free-ranging bison in the Prince Albert National Park area of Saskatchewan in 2008. The Canadian Veterinary Journal 50: 152-154.

Sigurdson, C. J. 2008. A prion disease of cervids: Chronic wasting disease. Veterinary Research 39: 41.

Stafford, N. T., M. D. Needham, J. J. Vaske, and J. Petchenik. 2007. Hunter and nonhunter beliefs about chronic wasting disease in Wisconsin. Journal of Wildlife Management 71(5): 1739-1744.

Stephenson, W. 1953. The study of behavior: Q-technique and its methodology. Chicago, IL: University of Chicago Press.

Thompson, A. K., M. D. Samuel and T. R. Van Deelen. 2008. Alternative feeding strategies and potential disease transmission in Wisconsin white-tailed deer. Journal of Wildlife Management 72: 416-421.

Webler, T., S. Danielson, and S. Tuler. 2009. Using Q method to reveal social perspectives in environmental research. Greenfield MA: Social and Environmental Research Institute.

Williams, E. S. 2005. Chronic wasting disease. Veterinary Pathology 42: 530-549.

Williams, E. S., and M. W. Miller. 2002. Chronic wasting disease in deer and elk in North America. Revue Scientifique et Technique-Office international des epizooties. 21: 305-316.

Williams, E. S., M. W. Miller, T. J. Kreeger, R. H. Kahn, and E. T. Thorne. 2002. Chronic wasting disease of deer and elk: A review with recommendations for management. Journal of Wildlife Management 66: 551-563.

Williams, E. S., and S. Young. 1980. Chronic wasting disease of captive mule deer: a spongiform encephalopathy. Journal of Wildlife Disease 16(1): 89-98.

Wobeser, G. 2002. Disease management strategies for wildlife. Revue Scientifique et Technique-Office international des epizooties, 21(1), 159-178.

Woodroffe, R. 1999. Managing disease threats to wild animals. Animal Conservation 2: 185-193.

Vaske, J. J. 2010. Lessons learned from the human dimensions of chronic wasting disease. Human Dimensions of Wildlife, 15(3): 165-179.

Zimmer, N. M. P., P. C. Boxall, and W. L. Adamowicz. 2012. The impacts of chronic wasting disease and its management on recreational hunters. Canadian Journal of Agricultural Economics 60: 71-92.

Zimmer, N. 2009. The economic impact of chronic wasting disease on hunting in Alberta. Edmonton: University of Alberta.

APPENDIX A: INTERVIEW OUTLINE

The interview design was emergent; specific questions may have been altered slightly, but the purpose of the interview will remain the same. The interview is intended to obtain information about how participants perceive chronic wasting (CWD) as a risk and what they perceive as the best solutions.

Q: Do you hunt deer or elk?

Q: [If participant owns cattle] Have you had problems in the past with wildlife-transmitted diseases in your livestock?

Q: [If participant farms deer or elk] Have you made any effort to prevent CWD from infecting your herd?

Q: Do you think CWD is a risk for you? (How/why?)

Q: Do you feel elk are significant to you? (How/why?)

Q: How do you think CWD risks should be managed?

Q: Who would you like to see involved in this process?

APPENDIX B: Q METHOD CONCOURSES

1. I like sharing my land with elk and deer.
2. Elk and deer are aesthetically important to me.
3. Elk and deer are important as part of the larger landscape.
4. CWD is a natural part of the environment.
5. CWD is part of a larger problem.
6. CWD will get here eventually.
7. Hunters are concerned about CWD and its impacts.
8. Farmers are concerned about CWD and its impacts.
9. Elk and deer populations are already too low.
10. There's less hunting because of CWD.
11. Everyone within the community has a responsibility to help address CWD.
12. Government organizations have the most significant role in actively managing CWD.
13. Everyone within the community should be involved in developing management plans that the government enacts.
14. Predators are an important part of CWD management.
15. It's important that management policy understand the impact on wildlife, ecosystems, and people.
16. Management decisions should be exclusively based on science.
17. CWD management should transcend boundaries.
18. For more effective management science should be better at engaging with laypeople.
19. CWD management should fit within the national CWD management strategy.
20. Management decisions should take into consideration what has been tried elsewhere.
21. Those who are impacted by CWD should be involved in management.
22. Education on CWD is important.

SK

23. If heads are sampled, it needs to be complete—including First Nations.
24. People in this area aren't scared of CWD.
25. Previously, hunting reduced the elk population significantly.

MB

23. Responsibility needs to be identified and allocated.
24. Hunter sampling is an issue.
25. Elk ranching has been a significant, high risk factor.
26. Transporting live animals for relocation is a high risk.
27. Better off informing the public than enforcing the border.
28. There are more elk on the landscape in small groups now because of rural depopulation.
29. CWD is talked about less because it isn't here. TB is the bigger issue now.

First Nations

30. Elk and deer are important to First Nations a resource for medicine, food and clothing.

31. First Nations should participate in making plans to work towards eliminating CWD.
32. Indian [First Nations] governments should have a significant role in actively managing CWD.